Royal Academy of Engineering

Government Office for Science

UK Intelligence Community Postdoctoral Research Fellowships 2025

Applicant guidance notes

Deadline: 29 April 2025

Royal Academy of Engineering
UK Intelligence Community Postdoctoral Research Fellowships 2025

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Programme Overview

The Government Office for Science offers UK Intelligence Community (IC) Postdoctoral Research Fellowships to outstanding early career science or engineering researchers. These Research Fellowships are designed to promote unclassified basic research in areas of interest to the intelligence, security, and defence communities. The National Protective Security Authority, Defence Science and Technology Laboratory, Home Office, the National Cyber Security Centre, and UK National Authority for Counter-Eavesdropping are among the organisations represented in the UK Intelligence Community for this scheme.

Each year members of the IC identify research topics, and the Research Fellows work locally with their University Research Advisor to develop and submit research proposals that align with the topics.

The research is conducted by the Research Fellows while working in partnership with the University Research Advisor and collaborating with an advisor from the Intelligence Community (IC Advisor).

The IC Advisor is the government representative for each topic. They are the responsible party from the government to track that the research of the UK IC Postdoctoral Research Fellow is in line with aims of the research topic.

The Research Fellowships are aimed at early career researchers from all branches of science and engineering who have up to five years postdoctoral experience. Only citizens of Australia, Canada, the EEA, New Zealand, Switzerland, the UK or the US can apply.

Please note there are no nationality restrictions for the University Research Advisors.

Each application for the UK IC Postdoctoral Research Fellowships is capped at a maximum contribution from the Royal Academy of Engineering (the Academy) **£250,000 over the 2-year period**, at 80% of the full economic costs (fE.C). Research Fellowships must be held at a UK higher education institution/university or at a UK research organisation that is eligible to receive UKRI funding.

In addition to the direct financial support, the scheme benefits include:

- Mentoring support from an Academy Fellow to offer advice on research and career development
- Expert advice and support from the IC Advisor
- Reduction of teaching and administrative duties to dedicate time to research
- Training, events and additional funding opportunities
- Networking opportunities with other Research Fellows, Academy Fellows and the IC Community
- Be part of the RAEng Awardee Excellence Community.

Awardees of this fellowship are eligible to apply for a Global Talent Visa under the fast-track process of endorsement.

Diversity and inclusion

The Academy is committed to diversity and inclusion and welcomes applications from all underrepresented groups across engineering. It is the Academy's policy to ensure that no applicant is disadvantaged or receives less favourable treatment because of age, disability, gender reassignment, marriage and civil partnership, pregnancy and maternity, race, religion or belief, sex, or sexual orientation.

Before you commence your application, you will be asked a few diversity monitoring questions to help the Academy monitor and assess our progress on diversity and inclusion in Academy programmes. It will only be used for statistical purposes with access restricted to staff involved in processing and monitoring the data. No information will be published or used in any way that identifies individuals. The Academy will retain personal information as per our Data Retention Policy in line with the General Data Protection Regulations 2018.

The information will be treated as strictly confidential, nonattributable and will not be seen by anyone involved in any selection processes. You will need to complete the diversity monitoring section before you can see the grant application form, but can choose "prefer not to say" as responses.

The Academy is committed to making reasonable adjustments to remove barriers that hinder applicants from applying.

Access Mentoring support

The Academy aims to provide additional support to applicants from groups that are persistently underrepresented within UK engineering through the grant application process. This positive action will contribute to improving diversity in the talent pipeline and widening the diversity of applicants and awardees within the Academy's research grant schemes.

To be eligible for Access Mentoring support, applicants must meet the eligibility criteria of the UK IC Postdoctoral Research Fellowships scheme and must be either:

- **Women**
- **Black people (including any mixed ethnicity groups that include Black ethnic backgrounds)**
- **Disabled people**

The Academy accepts applicants' self-declaration on the above identified underrepresented groups.

Access Mentoring is a resource-limited opportunity. Applicants do not need to wait until the deadline to submit and early submission is encouraged. Mentors will be assigned on a first come first served basis. For more information on Access Mentoring please see guidance and how to apply

Part-time and flexible working

The Academy wants to support applicants to achieve a balance between their personal and work demands, and is happy to discuss individual requirements and consider part time and other flexible working arrangements.

The Academy will expect the awardee to contribute no more than four hours per week towards teaching, administrative and non-research duties during their award (this will be pro-rated for part-time awards). Awardees may engage in other employment or academic activities outside of the time allocated to their award.

UK IC Postdoctoral Research Fellowships can be held part-time, but must be the only form of employment. Requests for a part-time Research Fellowship (at no less than 50% of full-time equivalent) must be clearly stated within the application. Alternatively, the Research Fellowship can be converted from full time to part time, or from part time to full time, during the fellowship, assuming the host institution supports the request.

Research Fellows are entitled to maternity, paternity and adoption leave under the host institution's normal conditions of employment. The Academy will extend the duration of the Research Fellowship pro-rata to take into account such periods of leave and any conversions to part-time working. Research Fellows with caring responsibilities should liaise directly with the host institution if they wish to apply for part-time or flexible working.

Submission deadline

There is one application round each year. The online application system for 2025 round will open in December 2024. The submission deadline for the 2025 round will be **4pm (UK local time)** on **Tuesday 29 April 2025**. Applicants will be informed of the result in July 2025.

Eligibility criteria

1. UK IC Postdoctoral Research Fellowships must be held at one of the following eligible institutions that can show it is capable of fully supporting the research project and researcher:
   - a UK higher education institution/university or
   - a UK research organisation that is eligible to receive UKRI funding. A list of eligible research organisations is included in Appendix A. However, organisations represented in the UK Intelligence Community for this scheme are excluded.

2. The applicant must be a citizen of Australia, Canada, the EEA, New Zealand, Switzerland, the UK or the US. If you hold dual citizenship, you are eligible to apply provided that at least one of your citizenships is from one of these countries. The host institution is responsible for securing all necessary work permits and related costs for the UK IC Postdoctoral Research Fellows.

3. There are no age restrictions for applicants.

4. A basic security check is required as part of the UK IC Postdoctoral Research Fellowship scheme. By applying to this scheme the applicant is agreeing to be security checked prior to the start of the Research Fellowship providing the required information (full name, date of birth, nationality and current address) to the funder/relevant governmental organisation who will perform the check. If the Research Fellow does not meet or complete the security check requirement, the UK IC Postdoctoral Research Fellowship award will be withdrawn.

5. The proposed research project must address one of the research topics outlined at the end of this document.

6. UK IC Postdoctoral Research Fellowships are aimed at early-career researchers. Applicants must have a PhD, which was awarded no more than **five years** before the submission deadline: **Tuesday 29 April 2025**. This period includes applicants' work experience in academia or/and in industry in the UK or/and worldwide. A margin of up to three months more than the five-year limit is acceptable. If applicants have had maternity/paternity leave or other extenuating circumstances (e.g., extended sick leave, national service, or caring responsibilities), this will be taken into consideration if the relevant dates and details are provided in the application form.

7. PhD students are eligible to apply, but must have been awarded their PhD (or the PhD has been unconditionally approved) before **1 August 2025** or the offer will be withdrawn.

8. The applicant must not hold a permanent academic position before the start of the UK IC Postdoctoral Research Fellowship. Probationary or fixed-term lecturers are eligible to apply if the probationary or fixed-term status remains till the start of the Research Fellowship.

9. UK IC Postdoctoral Research Fellowships must begin between 1 October 2025 and 1 January 2026. The duration of a UK IC Postdoctoral Research Fellowship is two years full-time, calculated on a pro-rata basis for part-time awards. Requests for a shorter UK IC Postdoctoral Research Fellowship are not accepted.

10. UK IC Postdoctoral Research Fellows will be employed by the host institution and are required to devote all their working time to the Research Fellowship programme of work. The UK IC Postdoctoral Research Fellowship must be the Research Fellow's only source of employment. The Research Fellow should be based at the host institution for more than 50% of the Research Fellowship. If the Research Fellow needs to work more than 50% of the Research Fellowship outside the host institution, justification must be provided in the application form (Choice of host institution).

11. Applicants who have applied to this scheme before and were unsuccessful are eligible to reapply. These applications will be considered as new applications.

12. Occasionally security vetting is required as part of the UK IC Postdoctoral Research Fellowship scheme, by applying to this scheme the applicant is agreeing to be vetted if it becomes necessary during the Research Fellowship. If security vetting is required and the Research Fellow does not meet the security vetting requirement or does not complete the vetting process in a timely manner, the UK IC Postdoctoral Research Fellowship award will be withdrawn*.

* *Please note that applicants for research topic 06, 'Utilizing a modern mobile to provide a level of TSCM capability,' will be required to undergo security vetting.*

Note: Nationality restrictions (eligibility criterion 2) and basic security checks (eligibility criterion 4) are required by the Government Office for Science. This is to mitigate risks in the researchers' relationships with UK government and to safeguard awardees. Nationality is a protected characteristic under the Equality Act 2010, however exceptions for the purpose of safeguarding national security are permitted.

We remind you also that:

- UK IC Postdoctoral Research Fellowships cannot be jointly hosted by multiple institutions.
- It is the applicant's responsibility to contact the host institution to gain their formal approval before submitting an application.
- Any applications that are incomplete or do not adhere to the guidance will be rejected.
- Once submitted the application form cannot be edited and updated.
- As part of this grant application process your name and email address will be provided to the funder/relevant governmental organisation collaborating on the project to perform the required basic security checks.

Mentoring and monitoring

Awarded IC Postdoctoral Research Fellows will work with the Academy to identify an Academy Fellow to be their mentor. The mentor will provide expert, independent advice, and support for the duration of the Research Fellowship and will also formally monitor the Research Fellow's progress for the Academy. In addition, UK IC Postdoctoral Research Fellows will be assigned an Intelligence Community Advisor (IC Advisor), who will advise the awardee and the University Research Advisor on the research project.

UK IC Postdoctoral Research Fellows must submit a progress report every three months throughout the duration of the fellowship as well as an annual report and expenditure statement at the end of each year. At the annual review meeting the Research Fellow, mentor and Academy staff will discuss the report, progress made and future plans. Research Fellows will also be asked to provide some key data on their annual performance (e.g. publications and additional research funding) for the purpose of auditing and reporting to the Academy's funders.

The UK IC Postdoctoral Research Fellow will be invited to attend the US Annual Intelligence Community (IC) Tech Week during the period of the Research Fellowship. For security reasons, in-person attendance is restricted to Awardees who are citizens of Five Eyes (FVEYS) countries: Australia, Canada, New Zealand, the United Kingdom, and the United States.

Duration

UK IC Postdoctoral Research Fellowships are for a two-year period with an evaluation after the first year. If the project warrants a third year of research and the Research Fellow, University Research Advisor, and IC Advisor concur, the Research Fellow is required to submit a supplementary research proposal. The proposal should not exceed three pages and must be emailed to the Academy no later than 1 January of the second year of research. This submission does not replace the annual reporting requirement. The third-year extension will be based on the quality of the research proposed and the availability of funding.

How to apply

All applications must be submitted via the Academy's online grants management system (GMS) available here: https://grants.raeng.org.uk. All applicants must first register and provide some basic login details to create a profile.

The application should be submitted by the applicant. We recommend leaving plenty of time to complete the application form ahead of the deadline and thoroughly going through your application prior to submission. While the guidance notes are embedded within the system itself, we recommend you keep this document to hand when completing the application form.

The application form has eight sections and should take approximately seven hours to complete, assuming you have answered the questions offline and merely need to enter the information, rather than compose it. To compose the application in its entirety will take significantly longer.

Many of the questions have prescribed word limits which are designed to keep your answers focused and indicate the level of detail we require. In such cases, the number of words you have used will be displayed beneath the question and updated in real time.

Applicants can download a pdf of their application after submission, which is recommend for reference. There is only one application stage and those meeting the eligibility criteria will enter the assessment stage.

Policy on National Security-Related Risks

The Academy is the UK's National Academy for engineering and technology and seeks to increase the potential positive benefit that innovations can have for society, whilst reducing the risks of harm. Hence, in all our activities, we seek to minimise the risk that technology developed as part of work that we support could be misused by a foreign state to build a capacity to target UK interests in a hostile fashion or to control or repress their population.

There is a risk that for some grant activities, failure to protect IP and a lack of due diligence into collaborators could result in sensitive technology being transferred to and misused by a hostile or repressive foreign state. As such all applicants should ensure they are familiar with the Academy's Policy on National Security-Related Risks.

Use of generative AI tools in funding applications and assessment

The Academy has aligned with other UK funders around the use of generative AI tools in funding applications through the Research Funders Policy Group joint statement.

Regarding the use of AI, applicants are fully responsible for all the content presented in their grant applications. The grant process does not penalise the use of generative AI tools, but it is imperative to ensure that the application reflects the applicant's own voice and ideas. It is not acceptable to solely rely on generative AI tools to write the entire grant application from start to finish. While these tools may be used to assist in various aspects, the application must primarily represent the applicant's own work.

Applicants must provide clear acknowledgement if they have used generative AI tools in the process of writing their grant applications. This includes disclosing the name of the tool used and describing how it was utilised. The following style should be employed for referencing:

I acknowledge the use of [insert AI system(s), version number and link] to generate materials for background research, styling, proofreading, etc.
Or,
I acknowledge the use of [insert AI system(s), version number and link] to generate materials that were included within my final assessment in modified form.

Subsidy Control

The UK subsidy control regime began on 4 January 2023. As part of this regime, the Academy is required to report to the UK Government on how award funding is being used when applications collaborating with commercial enterprises are awarded. The regime determines the lawfulness of monetary awards made using public sector resources when given to businesses and other organisations that are engaged in economic activity.

To assist with subsidy control compliance you must confirm whether your research project is either a piece of non-economic scientific research (with or without commercial collaborators) in terms of the Statutory Guidance on Subsidy Control clause 15.33 or an Industrial Research project with identified commercial collaborator(s). More info available in section 5 within the application form.

Research involving human participants or tissue

Research, development and innovation involving human participants, human material or personal data can contribute to a better understanding of human health and disease as well as the technological efficacy of new and evolving innovations. The Academy will fund research, development and innovation involving the use of human participants, human material or personal data which complies with our Humans in RD&I Policy. If your proposal includes the use of human participants, human materials or personal data you will be asked to provide details of your work at application stage.

Please note: applicable regulatory approval and licenses are not required to be in place at point of application, but all necessary approvals must be in place before the work begins and a clear plan to achieve this at application stage.

Animals in research

The Academy acknowledges that, at present, the use of animals remains the only way for some areas of research to progress. Research involving animals is regulated by comprehensive and strict legislation in the UK and must be conducted with a high regard for animal welfare. The Academy will fund work involving the use of animals in the UK which complies with our Animals in RD&I Policy. If your proposal includes the use of animals you will be asked to provide details at application stage.

If your proposal involves the use of animals and takes place outside of the UK, the Academy will generally not fund this work. Please contact the Academy before proceeding with your application.

Please note: applicable regulatory approval and licenses are not required to be in place at point of application, but all necessary approvals must be in place before the work begins and a clear plan to achieve this at application stage.

Completing the application form

After logging into the GMS and selecting 'UK IC Postdoctoral Research Fellowships', you should be presented with the 'Instructions' screen. Here you will see some general instructions on how to use the system, as well as links to each of the eight sections of the application form given below:

1. Applicant and institution details
2. Applicant profile
3. Project details
4. Subsidy control compliance
5. Responsible research
6. Resources requested
7. Statement of support and declarations
8. Marketing

At any stage in the application process, you can save your work and return to it later. You can answer the questions in any order you like, so you may skip some sections to return to later if you wish. We recommend viewing the application early on to understand what is required. You should also ensure that you have all the necessary documentation to hand when you start completing the application, such as a copy of your CV or letters of support.

Please read the guidance provided in this document in detail before starting an application.

Once submitted the application form cannot be edited and updated.

1. Application and institution details

Q. Applicant name and contact details

Please provide your name and preferred contact details. You should also provide the details of the host institution where the UK IC Postdoctoral Research Fellowship will be held and confirm that this is the 'lead organisation'.

Q. Nationality

Applicants must be citizens of Australia, Canada, the EEA, New Zealand, Switzerland, the UK or the US. Select one of the options from the drop-down list. This section is not visible to reviewers.

Q. Security check confirmation

A basic security check is required as part of the UK IC Postdoctoral Research Fellowship scheme. If the Research Fellow does not meet or complete the security check requirement, the UK IC Postdoctoral Research Fellowship award will be withdrawn.

Please tick the checkbox to confirm you are agreeing to be security checked prior to the start of the Research Fellowship providing the required information (full name, date of birth, nationality and current address) to the funder/relevant governmental organisation who will perform the check. You are also confirming that you are aware that as part of this grant application process your name and email address will be provided to the funder/relevant governmental organisation collaborating on the project. This section is not visible to reviewers.

Q. Security vetting confirmation

Occasionally security vetting is required as part of the UK IC Postdoctoral Research Fellowship scheme, by applying to this scheme the applicant is agreeing to be vetted if it becomes necessary during the Research Fellowship.

If security vetting is required and the Research Fellow does not meet the security vetting requirement or does not complete the vetting process in a timely manner, the UK IC Postdoctoral Research Fellowship award will be withdrawn.
Please tick the checkbox to confirm you are agreeing to be vetted if it becomes necessary during the Research Fellowship. This section is not visible to reviewers.

Q. Contact details of the host institution

Please provide the name and contact details of your host institution. if you are not currently employed by the host institution, you should also add your current employer. Please mark the host institution as the 'Lead Organisation'.

2. Applicant profile

This section requests details as to your suitability and eligibility for the UK IC Postdoctoral Research Fellowship. You will need to answer some general questions on your experience and upload your CV.

Q. What date was/will your PhD Certificate awarded?

Applicants must have a PhD, which was awarded **no more than five years** before the submission deadline (**29 April 2025**). PhD students are eligible to apply, but must have been awarded their PhD (or their PhD has been unconditionally approved) before **1 August 2025**. Please enter the date your PhD Certificate was awarded or the date your PhD was unconditionally approved by the university. If you have not received your PhD yet, please provide an estimate of when it will be awarded or unconditionally approved. This section is not visible to reviewers.

Q. Extenuating circumstance (optional question)

If your PhD Certificate was awarded more than five years before the submission deadline (**29 April 2025**), please provide details of the extenuating circumstances. Please cover any periods of maternity/paternity leave, extended sick leave, national service, part-time employment for caring responsibilities or other activity that you feel should be considered when assessing your eligibility for the UK IC Postdoctoral Research Fellowship. The Academy's decision on eligibility is final. This section is not visible to reviewers. This section is not visible to reviewers.

Q. Do you currently hold a permanent academic position?

Applicants must not hold a permanent academic position before the start of the UK IC Postdoctoral Research Fellowship. This section is not visible to reviewers.

Q. Applicant's CV

The format and content of your CV is left to your discretion, but should include a list of publications. You may wish to indicate which publications you deem most significant and include a link to any that are open access. You do not need to include contact details as these are included earlier in the application form.
Please do not include personal information (e.g., gender, date of birth, and nationality) in the CV. The CV must be uploaded in a single PDF and the file size should be less than 5MB.

Q. Applicant's most significant achievements

Please describe three to five of your most significant achievements in your research career. We would like to emphasise that all achievements and outputs are welcome and considered valuable to the Academy, not just peer-reviewed publications. Outputs also include, and are not limited to code, patents, spin-out companies, events, public engagement, and policy impact. Please briefly explain the significance of the achievement in a way that will explain it to a researcher from your discipline who may not be familiar with the latest work in the particular field.
500 words maximum

The Academy's research programmes are aligned with the principles of DORA. If research articles published in peer-reviewed journals are to be included in an application, we would therefore like to emphasise that the scientific content of a paper is much more important than publication metrics or the identity of the journal in which it was published.

Q. Impact of COVID-19 (optional question)

The Academy understands that the impact of the coronavirus pandemic on researchers and their work is varied. If you wish, please provide a summary of how the pandemic has affected your research profile development that reviewers and panel members should consider. Reviewers and panel members will be advised to take into consideration the unequal impacts that COVID-19 related disruptions might have had on individuals.

The impact can include, but is not limited to, the following examples: pause on experiments/research plans, reduced ability to work due to additional caring responsibilities, delays in publishing/submitting a key paper(s) (please note pre-prints can be included in your publications list).
500 words maximum

3. Project details

Q. Research topic

Select one of the research topics relevant to your application from the drop-down list. The research topics are outlined in Appendix B at the end of this document.

Q. Project title

The essence of the research should be captured in the title and should be as informative as possible. Please use **no more than 10 words** and ensure that it is **understandable to a non-specialist reader.**

Q. What is the start date of the proposed project?

UK IC Postdoctoral Research Fellowships must begin between **1 October 2025** and **1 January 2026**. The duration of a Research Fellowship is two years full time, calculated on a pro-rata basis for part-time awards. You must agree these timescales with the host institution. Requests for a shorter Research Fellowship are not accepted.

Q. What is the end date of the proposed project?

Example, if your project starts on 1 October 2025, it will need to finish two years later (on 30 September 2027).

Q. Abstract

Describe the research in terms that can be understood by a non-specialist reader. What similar research is being/has been undertaken nationally and internationally, and how does your project differ?
300 words maximum

Q. Statement of problem

A brief outline of the basic facts of the problem, explain why the problem matters, and pinpoint a solution as quickly and directly as possible.
200 words maximum

Q. Background and relevance to previous work

Sufficient details should be given in this discussion (1) to make clear what the research problem is and exactly what has been accomplished; (2) to give evidence of your own competence in the field; and (3) to show why the previous work needs to be continued.

1000 words maximum

Q. General methodology

Please provide a detailed description of the exact work to be completed. Describe the programme of work, indicating the research to be undertaken and the milestones that can be used to measure progress. Detail the methodology to be used in pursuit of the research and justify this choice. What similar research is being/has been undertaken nationally and internationally, and how does your project differ?

1000 words maximum

Q. Explanation of new or unusual techniques (optional question)

If you are using any techniques that are not standard in the area of the research proposed, please explain the technique and the rational for using it.

500 words maximum

Q. Expected results and their significance and application

Describe what you expect to get out of the research. It should join the data analysis and possible outcomes to the theory and questions that you have raised. Summarise the significance of the work and proposed applications.

1000 words maximum

Q. Project timeline

Upload a Gantt chart or equivalent to show the schedule of activities for the duration of the UK IC Postdoctoral Research Fellowship. Please ensure major milestones are clearly plotted. You may wish to include a diagram showing how the work packages and your collaborations – if any - will interact. **The chart/ diagram must be collated and uploaded as a single PDF.**

Q. Choice of host institution

Explain your choice of host institution. You may wish to comment on the facilities and local expertise that will be available to you. You should also cover what experience you have had and/or plan to gain from other institutions and alternative working practices. For example, any time spent on secondment or on extended visits.

200 words maximum

Q. Academy's strategic goals (optional question)

How do you align with the Academy's strategic priorities? Note this is not an assessment criterion and is for staff use only. We want to understand the extent to which our programmes as a whole meet our strategic aims, but your answer will not influence the decision and applications are judged purely on merit. The strategic plan is available on our website here.

Select the answer that best describes the strategic aims your research will address:

- Sustainable society
- Inclusive economy
- Both
- Neither

Please give a short explanation for the answer you have selected.
100 words maximum

Q. Diversity and inclusion

The Academy strives to create cultures in which everyone can thrive, and we believe that diverse perspectives enrich our collective performance. What does diversity and inclusion mean to you and your research, and what are you and your team doing to address it? Consider your team, collaborators and universities, the implications on your research design and topic and the overall contribution this will have on your success.
250 words maximum

Q. Reference list

List the reference material referred to in your application. Where possible include web links to any open access articles to help reviewers in locating the articles. You may want to highlight the most relevant ones.
700 words maximum

Q. Images and diagrams (optional question)

Upload any images and/or diagrams related to your project that add value to your application. Any images/diagrams uploaded must be referenced in the application form. **The images/diagrams must be collated and uploaded as a single PDF** in the order you wish them to be viewed.

4. Responsible Research

The following questions address responsible research practices in alignment with the Academy's Animals in Research and Humans in Research policies.

For proposals involving animals or animal tissue, and for research involving human participants, tissue, or personal data, you must provide detailed information to ensure compliance with ethical and regulatory standards. While applicable approvals and licenses are not required at the point of application, all necessary approvals must be secured before the work begins, with a clear plan outlined at the application stage.

For further guidance, please refer to the linked policies.

Animals in research, development or innovation questions

Q. Does your proposal involve the use of animals or animal tissue?
This is a multiple-choice question and requires you to declare if your proposal includes research involving animals or animal tissue and whether that research is conducted within the UK and the UK's regulatory regime or outside the UK. If your research is going to be conducted outside of the UK, you must speak to an Academy staff member to assess whether we would be able to fund this type of research before beginning your application. If we are able to fund it, we will also ask you where it will take place and to provide details of the local legislation and ethical review procedures.

Q. Why is animal use necessary; are there any other possible approaches?
We require sufficient details to enable us to ensure that you have aligned your research with the NC3Rs and our Academy policy, particularly that you are able to explain why there is no alternative to using animals in the research and the ethical implications of the planned experiments.

Q. Do your experiments involve the use of non-human primates (NHPs), cats, dogs or equines, which are specially protected species under the Animals (Scientific Procedures) Act 1986?
This is a yes or no question. If your experiment does involve the use of non-human primates we may send your application to additional independent experts for review.

Q. Please provide details of the animal species and number(s) to be used?
This and the following question require you to justify the number, species and sex of animals you are planning to use, clearly describing how the planned experimental design is appropriate to give robust results.

Q. Why is the species/model to be used the most appropriate?
Please discuss the relevance of your model(s) along with any limitations and how you have accounted for this within your study design.

Q. Please explain how you have considered the NC3Rs in your research design? You may also upload any supporting documents (ie the Experimental Design Assistant or power calculations) however this is not required at this stage.
This question allows us to assess if your research complies with the principles of Replacement, Reduction and Refinement and that you will ensure distress and pain are minimized and the severity level for all procedures is the lowest possible.

Q. Please provide information on your plan and the timeline to acquire all relevant ethical approval and licenses.

Human Participants in Research, Development, and Innovation questions

Q. Does your proposal involve human participants, as according to the WHO definition?

Q. Does your proposal involve the use of human tissue or other human material?

Q. Does your proposal involve the use of personal data?
These three questions require you to declare if your proposal involves the use of human participants, human tissue and/or other human material or personal data. The questions are all multiple-choice, and depending on your responses, you will be asked further questions providing details on the location, regulatory regime and research plan.

(For any work to be conducted outside of the UK)

Q. Please confirm the country where the work will be conducted.
This and the following two questions provide us sufficient details to ensure that you have aligned your proposed work with the Academy's policy, particularly our requirement that research complies with relevant legislation and the governing principles of the Declaration of Helsinki, the Nuremberg Code, and the Council for International Organizations of Medical Sciences (CIOMS) guidelines, all of which set out requirements with regard to the rights and safety of research participants and standards for research design and conduct.

(For any work to be conducted outside of the UK)

Q. Please provide details of the local legislation and ethical review procedures if the work is to be conducted outside the UK.

(For proposals involving human participants or human tissue)

Q. Please provide information on your plan and the timeline to acquire all relevant ethical approval and licenses.

Q. For proposals involving human participants, please explain you will protect the dignity, rights, safety and wellbeing of all participants, particularly when involving vulnerable groups.
This question assesses whether your proposed work protects the dignity, rights, safety and wellbeing of all participants, particularly when involving vulnerable groups and avoids exploitation and undue inducement of participants.

Q. For proposals involving human tissue and/or other human material, please explain how you will safeguard the collection and/or storage of human tissue/ other material and comply with all relevant legislation.
This question seeks to ensure that your proposed work involves the suitable safeguarding or the collection, storage and access of human tissue in compliance with the appropriate legislation (the Human Tissue Act 2004 for England, Wales and Northern Ireland and the Human Tissue (Scotland Act 2006 for Scotland).

Q. For proposals involving personal data, please explain how you will safeguard the collection and/or storage of personal data and comply with all relevant legislation.
This question seeks to ensure that your proposed work involves the suitable safeguarding of personal data and compliance with all relevant legislation, including UK General Data Protection Regulations (UK GDPR) for research conducted in the UK, and the duty of confidentiality and informed consent.

5. Subsidy control compliance

This programme most commonly awards grants on the basis that they are for non-economic research conducted without a collaborating commercial organisation. However, should a research organisation declare that a commercial organisation is to gain a direct benefit from the project then the Academy would award the grant under the Streamlined route for RD&I (SC10780) on the basis that it is an **industrial research** project that represents an indirect subsidy to the commercial organisation.

The Academy will **not** fund projects that would be classified as be **feasibility studies** or **experimental development** projects as defined in the **Research, Development and Innovation Streamlined Subsidy Scheme** guidance.

Should the project be classified as an Indirect Industrial Research project and subsequently awarded as an indirect subsidy to the collaborating enterprise then the Academy will need to seek assurances about the level of funding already received by that commercial organisation in respect of the project to ensure compliance with the cumulation rules of the streamlined route, and ensure that funding for that project has not nor will exceed the £3M cap by awarding of the proposed grant.

Per the streamlined route, the subsidy ratios allowed for an Industrial Research Project are: 85% for small enterprises, 75% for medium-sized enterprises, and 65% for large enterprises with the enterprise required to commit to, and demonstrate input at, the required level to comply with those ratios i.e. if the Academy awarded 85k for a Grant and the collaborating commercial organisation was a small enterprise they would be required to commit and evidence on request the required input 15k of funds for eligible costs under the streamlined route.

The eligible costs for all industrial research projects must align with the allowed costs per the **RD&I Streamlined** route and can include: personnel costs: the costs of researchers, technicians and other supporting staff to the extent employed on the project, costs of instruments and equipment, to the extent employed on the project, costs of buildings and land, to the extent and for the duration period used for the project. costs of conducting research and of external consultancy and contractual research or other knowledge assets, including patents bought or licensed from outside sources, and any other project operating costs and project overheads; including costs of materials, supplies and similar products, incurred directly as a result of the project.

Where equipment and instruments are not used for their full life for the project and have a useful life or residual value beyond the period of the project then the residual value should be deducted when calculating the eligible costs. In the case of small and medium enterprises (SMEs) the remaining value of new equipment and instruments purchased for the project may be a fully eligible cost providing they are used for the rest of their useful life after the project for research, development and innovation activities and to improve research, development and innovation capability. This section is not visible to reviewers.

Q. To assist with subsidy control compliance, please confirm whether your research project is either:

a) a piece of non-economic scientific research (with or without commercial collaborators) in terms of the Statutory Guidance on Subsidy Control clause 15.33 “Non-economic scientific research may be carried out in collaboration with commercial organisations, as long as the commercial organisation does not receive a specific benefit from the financial assistance given to the research organisation. This would be the case, for example, where the commercial organisation pays the full cost of the project; or where results that do not give rise to intellectual property rights may be widely disseminated and where any intellectual property rights arising from the project are allocated to the organisations involved in a manner which reflects their contributions (i.e. intellectual property rights resulting from the activities of the research organisation are fully allocated to it). The commercial organisation is also unlikely to benefit if the research organisation receives compensation equivalent to the market price for the intellectual property rights which result from their activities.”

or

b) an Industrial Research project with identified commercial collaborator(s) ("Industrial Research means the planned research or critical investigation that is aimed at the acquisition of new knowledge and skills for developing new products, processes or services; or that is aimed at bringing about a significant improvement in existing products, processes or services"). For more details, see RD&I Streamlined route guidance 14.3.

Select the option relevant to your application from the drop-down list.

Q. Are you collaborating with a commercial organisation on this project?
If your answer is 'Yes', then you need to reply to the following questions.

Q. How many commercial organisations are you collaborating with?
Please state the number.

Q. Can you confirm that when working with that commercial organisation(s) that results that do not give rise to intellectual property rights will be available to be widely disseminated and that any intellectual property rights arising from the activities of the research organisation fully allocated to it?
If yes, this should also be confirmed by the Recipient Organisation in their support letter. If your answer is 'No', the grant may be a subsidy and the Academy will need to review the particulars of the benefits to the commercial organisation(s).

In the event the grant is deemed to be a subsidy, further investigations will need to be carried out to ensure we comply with funder regulations.

6. Resources requested

Applicants must consult with the host institution for support in completing the costs table. Please ensure that you allow plenty of time for the host institution to prepare the costings. The below categories explain what costs should be included in your application. You must be able to demonstrate that the resources requested are justified and appropriate for delivering the proposed research.

Each application is capped at a maximum contribution from the Academy of £250,000 over the two-year period, at 80% of full economic costs (fEC). The host institution is expected to provide any shortfall from its own funds or other grants.

Q. Costs table

When completing the costs table, some of the cells are auto-calculated and all values submitted should be rounded up to the nearest pound. **Please do not show actual fEC in the costs table**. In the costs table, the total funding requested from the Academy cannot exceed £250,000 at 80% fEC (the actual costs at 100% fEC cannot exceed £312,500)

6.1 Directly incurred costs

Staff

The UK IC Postdoctoral Research Fellowship's aim is to support researchers at an early stage of their research career. Salary should be at a level commensurate with skills, responsibilities, expertise, and experience. It is expected that requested salary will be comparable to postdoctoral researcher or early-stage lecturer salary scale points. The Academy reserves the right to provide support at a different level if it is considered appropriate.

The Research Fellow's salary can be requested for a period of two years full time equivalent. Salary increments over the period of the Research Fellowship should be considered in the costs, but possible future pay awards should not be anticipated. **Please note that the Academy does not pay inflation and inflation should not be applied to the costs.** In addition, the Academy is not able to cover the costs of the apprenticeship levy on research grants. Salary costs do not need to be justified in the 'Justification of costs' section.

The UK IC Postdoctoral Research Fellowship may be held on a part-time basis if the applicant is employed part time (minimum 50%). Applicants wishing to hold the award on a part-time basis must state the % time in the 'Justification of costs' section and explain why part-time working is requested. The costs table should be completed as if for a full-time fellowship and costs will be adjusted accordingly if the award is offered.

Please note:

- No other staff salaries can be requested as part of a UK IC Postdoctoral Research Fellowship.
- The UK IC Postdoctoral Research Fellowship must be the Research Fellow's only source of employment. Research Fellows are required to devote all their working time to the Research Fellowship programme of work. Research Fellows are encouraged to apply for further funding. However, any additional funding must not result in a reduction in the Research Fellow's time working on the Research Fellowship and cause a delay in the completion of the UK IC Postdoctoral Research Fellowship.

Travel and subsistence

Travel and subsistence costs can only be requested for the Research Fellow and must be for activities directly related to the research project. Travel costs should be based on the most suitable, cost-effective and environmentally friendly form of travel. Subsistence costs should reflect the normal rates that apply in the host institution. Commuting costs for working at the host institution cannot be requested.

Costs for attending national and international conferences (including two visits to the US Annual Intelligence Community (IC) Tech Week*) may also be included where such attendance will directly benefit the research project. Conferences should, as far as possible, be individually identified in the proposal with attendance costs and fees fully justified in the 'Justification of costs' section.

**Please note due to the venue security restriction only citizens of Australia, Canada, New Zealand, the UK and US can attend the event in person.*

Other Costs

Other costs should be specified and justified in the 'Justification of costs' with details provided in terms of their requirement for the research project. Examples include purchase or hire of small items of equipment, computer software licences, cloud computing/compute time at external facilities, laboratory consumables, purchase of specialist publications, open access costs, publication/printing costs, professional membership subscription fees or training costs. Unless the need for significant computing power can be justified, the costs requested from the Academy for the purchase of a computer should not exceed £3,000 (including VAT), and no more than one computer should be requested over the duration of the UK IC Postdoctoral Research Fellowship.

The cost of any single item of equipment, software, cloud computing/compute time fees, database subscription or upgrade to existing equipment, requested from the Academy should not exceed £10,000 (including VAT). Should any piece of equipment include multiple separate items that are purchased individually and then combined to make a single functioning system, the cost of the entire system requested from the Academy should not exceed £10,000 limit.

Costs for major facilities not owned by the host institution, such as those supported by STFC, cannot be requested. If such facilities are required for the project, the applicant should contact the specific facility to determine access requirements. If access to a facility is essential to the research project, both access to and external funding for the cost of the facility must be secured within one year of the proposed start date of the UK IC Postdoctoral Research Fellowship.

Research Fellows are expected to make full use of any equipment that is available at the host institution and should therefore only request funding for equipment that is necessary and not currently available.

6.2 Directly allocated costs

Estates

Research Fellows may apply for estates costs for the duration of the UK IC Postdoctoral Research Fellowship. Estates costs do not require justification in the 'Justification of costs' section. Where the Research Fellow will be away from the host institution for six months or more in total, estates costs should not be requested for that period. In such situations, this should be confirmed in the 'Justification of costs' section.

Other directly allocated

Other directly allocated costs can be requested, calculated based on estimates and should be justified in the 'Justification of costs' section. Potential costs include the host institution's research/technical staff whose time is shared across several projects and charge out costs for existing equipment owned by the host institution, for example access to departmental SEMs and analytical facilities Salary costs for specific technicians cannot be requested, costs for pool technician time for the use of facilities/equipment at the host institution can be requested.

6.3 Indirect Costs

Indirect

Please consult with your host institution for guidance as to these costs. Research Fellows may apply for indirect costs for the duration of the UK IC Postdoctoral Research Fellowship. Indirect costs do not require justification in the 'Justification of costs' section. Please refer to the efficiency savings published by RCUK in March 2011 when submitting your figures for indirect costs.

Q. What is the total value of the award requested from the Academy?

Please state the total value of the funding you are requesting from the Academy. This is the value of the two years at 80% fEC, up to a maximum of £250,000.

Q. Justification of costs

Please provide a narrative description of what resources are being requested and why. Ensure you have adhered to the guidance provided for allowable costs as detailed above. The justifications should include:

- all necessary justifications for costs included in the costs table
- to what extent the equipment requested will be used by other researchers and what equipment you are not requesting funding for (or for which you are requesting funding at a reduced rate) because suitable equipment is already available to you
- what costs will be covered by other sources, for example industry or existing grants, so are not being requested as part of the application
- if relevant, an explanation of why you wish to work part time and at what rate.

500 words maximum

7. Statement of support and declarations

This section seeks confirmation that the applicant has provided accurate information and will update the Academy of any material changes, which may affect the award. It should also confirm that the host institution will support the UK IC Postdoctoral Research Fellowship. You must upload all the additional documentation as explained below and then tick the box confirming the information provided is correct. **The submission deadline will not be extended due to an individual's unavailability.**

Q. Research Advisor's statement of support

The University Research Advisor must provide a statement in support of the application and clearly states their role, responsibilities, and support for the duration of the UK IC Postdoctoral Research Fellowship. The statement should be submitted as a **PDF with a maximum length of two pages** on headed paper and signed.

Q. Research Advisor's CV

The CV must not exceed two pages, should be submitted as a **PDF and the file size should be less than 5MB.**

Q. Host institution letter of support

The head of department or school, pro-vice-chancellor or dean or director at the host institution must provide a statement in support of the application. The statement must be on headed paper and signed. The statement should be submitted as a **PDF with a maximum length of two pages** and address the following areas:

Suitability of the applicant:

- quality of the applicant's research track record
- potential of the applicant to become a future leader in their chosen field
- potential to act as an ambassador and advocate for the research

Support and commitment from the host university:

- alignment of the proposed Research Fellowship with university research strategy and priorities
- details of mentoring, resources and support that will be provided to the applicant, should the application be successful
- other activities the applicant will be expected to undertake
- detail of the career development support that the applicant will be offered
- details of how the host institution adopts a proactive approach in encouraging researchers from underrepresented groups in engineering, to apply
- evidence of the host institution's commitment to equality and diversity
- confirmation that when working with the commercial organisation(s) that results that do not give rise to intellectual property rights will be available to be widely disseminated and that any intellectual property rights arising from the activities of research organisation fully allocated to it.

Impact of COVID-19 on the host university's support

The host institution can use this letter of support to highlight the impact of the coronavirus pandemic on their support for the UK IC Postdoctoral Research Fellowship if they wish. Reviewers and panel members will be advised to take into consideration the unequal impacts that COVID-19 related disruptions might have on the host university's support for the Research Fellowship.

The Academy and the Government Office for Science expect the host institutions to be committed to and provide support that aligns with principles set out in The Concordat to Support the Career Development of Researchers and The Concordat for Engaging the Public with Research, and DORA.

Q. Host institution declaration

The host institution's declaration letter must be completed by an appropriate individual from the institution's research support office or equivalent. **The letter must be in PDF, on headed paper and should carry the signatory's name, position, contact details**, and the institution's official stamp (if available).
The purpose is to check that the host institution is in principle willing to host a Research Fellow, subject to grant agreement. The letter must confirm the application has been approved by the institution and must contain the wording given in the box below, as well as any further remarks the host institution wishes to make. **Please note that the wording provided in the box below is specific to the UK IC Postdoctoral Research Fellowships scheme, and the wording is updated and different to previous rounds.**

On behalf of the host institution, I can confirm that I have read and accept the application guidance and other information regarding this award scheme, which is provided on the Royal Academy of Engineering's website. I also confirm that:

- the costs submitted in the application are correct and sufficient to complete the project as envisaged. Any shortfall in funding discovered after the award has been made will be covered by the institution, potentially through other grants.
- the applicant will be employed by the institution for the duration of the award.
- if awarded, the applicant will be given full access to the facilities, equipment, personnel, and funding as required by the application.
- The applicant's teaching, administrative and non-research duties will be restricted to enable them to dedicate their time to research.
- We are aware that the UK IC Postdoctoral Research Fellowships scheme has non-standard intellectual property rights (IPR) conditions relating to or resulting from the proposed research. If the proposal is recommended for funding, we will be ready to assess the IPR conditions in the offered grant agreement.
- I am authorised to approve the submission of applications for funding and confirm this application has successfully met the eligibility criteria and all our internal approval procedures.

Q. Letters of support (optional section, but this is your opportunity to demonstrate wider support for you and your project)

Each letter of support must:

- be on headed paper and clearly state who they are from
- be from external collaborators i.e., people and organisations NOT working at the host institution and its affiliates
- be signed
- confirm that the author knows the applicant
- explain why they are interested in the project
- provide details on what form the collaboration will take
- clearly demonstrate the nature of the collaboration and how it will be beneficial to the applicant and the project
- **be no more than two pages.**

Aim for quality over quantity. Shorter, more concise letters better enable the reviewers to identify the salient information. A bullet-point list of contributions can be an effective way to present the information.

The letters of support must be collated and uploaded as a single PDF.

Q. Acknowledgment of Use of Generative AI Tools (optional question)

Please provide a clear acknowledgment if you have used generative AI tools in the process of writing your grant application. This includes disclosing the name of the tool used and describing how it was utilised, following one of the formats provided in the application form.

200 words maximum

Q. Applicant declaration

Please tick the checkbox once you have read and understood the declaration included in the application form.

8. Marketing

This section is optional, but helps the Academy to understand which of our marketing materials are most successful at reaching the academic community and helps us to improve our future communications work.

A grey **'submit application'** button will become available once the application form is completed.

Please note that once submitted the application cannot be edited and updated, but you may view it from your GMS account.

Assessment process and criteria

The scheme has one-stage assessment process. Applications will be assessed by reviewers consisting of the UK government intelligence, security, and defence community members (under the auspices of the Government Office for Science) and Academy Fellows. The reviewers will provide comments against each of the following assessment criteria, the overall quality of the application and make a recommendation on whether the applicant should be funded.

It is important to note that the scores and comments from the topic authors carry significant weight in the evaluation process. A project may face challenges in securing funding if the topic author provides a negative assessment, as their expertise is closely tied to the relevance and feasibility of the proposed work.

The selection panel will consider the reviewers' comments and select the top ranked candidates for awards. To ensure both diversity and excellence, awards will be distributed across the different topics.

1. Candidate

- quality of the applicant's research track record.

2. Research quality and vision

- quality of the applicant's research vision, relevance, and novelty of the approach to the chosen research topic.
- quality and appropriateness of research methods and ethical and inclusive experimental design (including, if relevant, alignment with the Academy's Animal Use and Human Participants in Research, Innovation and Development Policies).

3. Impact

- the potential contribution of the research to the UK government intelligence, security, and defence community.

3. Research environment

- quality and level of support and commitment from the University Research Advisor and the host institution to complete the research fellow's research project and support their career development.

Declaration on Research Assessment (DORA)

The Academy's research programmes are aligned with DORA, which is a set of principles aiming to improve the ways in which the output of research is evaluated by funding agencies, academic institutions, and other parties. The outputs from research are many and varied, and as a funder of engineering research the Academy needs to assess the quality and impact of these outputs in order to make awards. It is imperative that research output is measured accurately and evaluated wisely.

In the assessment of research output, we would like to emphasise that all outputs are welcome and considered valuable to the Academy. Outputs can include open data sets, software, publications, commercial, entrepreneurial, or industrial products, clinical practice developments, educational products, policy publications, evidence synthesis pieces, and conference publications. With regard to research articles published in peer-reviewed journals, the scientific content of a paper is much more important than publication metrics or the identity of the journal in which it was published.

We value and appreciate the time and effort that reviewers give to support our research programmes. A good, helpful review for the Academy is one that assesses research on its own merits rather than by surrogate measures, such as on the basis of the journal in which research is published.

Why applications are unsuccessful

The most common reasons applications are unsuccessful:

Topic	The proposal does not meet the chosen research topic and requirements.
Track record	Applicants' research track record is not strong and relevant to the chosen research topic.
Collaboration	Unclear on potential collaborator plans including industrial/ clinical collaborations and clear routes to impact and exploitation.
Competitors	Not knowing and acknowledging competitors.
Vision	Vision and ambition not clearly explained in line with the chosen research topic and requirements
Novelty	Proposal lacking novelty, or not articulating how the proposed work will address the research topic.
Realistic	Unrealistic in terms of overstating potential impact. Also, milestones, resources, and the applicant's ability.
Support	Lacking strong letters of support from the host institution, University Research Advisor or industrial partner and potential collaborators.
Communication	Inconsistent/unclear information provided in the application form.

Grant agreement

If you are successful, your funding will be awarded under the RD&I Terms and Conditions found on the Academy's website.

This agreement has been developed to ensure funding aligns with our Academy values, is used for the purposes for which it was awarded, and is managed in compliance with our own funders' agreements, UK legislation and funding best practice.

If you have any questions please refer to our FAQs or contact the Royal Academy of Engineering's research programmes team at research@raeng.org.uk

Appendix A: List of eligible research organisations to host UK IC Postdoctoral Research Fellowships

Please note that these lists are accurate at the time of publishing. An updated list of eligible research organisations can be found on the UKRI website.

Eligible research institutes funded by the UK research councils

1. Alan Turing Institute
2. Babraham Institute
3. Culham Centre for Fusion Energy (part of UK Atomic Energy Authority)
4. Diamond Light Source
5. Earlham Institute
6. Health Data Research UK
7. Isaac Newton Group
8. John Innes Centre
9. Joint Astronomy Centre
10. Medical Research Council (MRC) Harwell Institute
11. MRC Laboratory of Molecular Biology
12. MRC Laboratory of Medical Sciences
13. Natural Environment Research Council (NERC) British Antarctic Survey
14. NERC British Geological Survey
15. Plymouth Marine Laboratory
16. Quadram Institute Bioscience
17. Rosalind Franklin Institute
18. Rothamsted Research
19. Scottish Association for Marine Sciences
20. Science and Technology Facilities Council (STFC) laboratories
21. The Faraday Institution
22. The Francis Crick Institute
23. The Pirbright Institute
24. UK Astronomy Technology Centre
25. UK Dementia Research Institute.

Eligible NHS bodies

1. the NHS board
2. NHS Clinical Commissioning Group
3. NHS Foundation Trust
4. NHS Special Authority
5. NHS Trust
6. NHS Local Health Board.

Eligible public sector research establishments

1. Animal and Plant Health Agency
2. Centre for Environment, Fisheries and Aquaculture Science
3. Defence Science and Technology Laboratory (not eligible for this scheme)
4. Environment Agency
5. Fera Ltd
6. Forest Research
7. Health and Safety Executive PSRE
8. Joint Nature Conservation Committee (JNCC)
9. Marine Scotland Science
10. Medicines and Healthcare products Regulatory Agency (MHRA)
11. National Nuclear Laboratory
12. National Physical Laboratory
13. Natural England
14. NatureScot (Scottish Natural Heritage)
15. Office for National Statistics
16. Science and Advice for Scottish Agriculture
17. UK Health Security Agency.

Eligible independent research organisations

1. Anthony Nolan
2. Armagh Observatory
3. BirdLife International
4. British Film Institute
5. British Institute of International and Comparative Law
6. British Library
7. British Museum
8. British Trust for Ornithology
9. Butterfly Conservation
10. CABI (Centre for Agriculture and Bioscience International)
11. Cambridge Arctic Shelf Programme
12. Cambridge Crystallographic Data Centre
13. Centre for Sustainable Energy
14. CERN
15. Chatham House (Royal Institute of International Affairs)
16. Earthwatch Institute
17. European Bioinformatics Institute
18. European Marine Energy Centre Ltd
19. European Synchrotron Radiation Facility
20. Historic Buildings and Monuments Commission for England
21. Historic Environment Scotland
22. Historic Royal Palaces
23. HR Wallingford Group
24. Imperial War Museum
25. Institute for Fiscal Studies

26. Institute of Development Studies
27. Institute of Occupational Medicine
28. International Institute for Environment and Development
29. London Institute for Mathematical Sciences
30. Malaria Consortium (UK)
31. Marine Biological Association
32. Moredun Research Institute
33. Museum of London Archaeology
34. National Archives
35. National Centre for Social Research
36. National Foundation for Educational Research
37. National Gallery
38. National Institute of Agricultural Botany
39. National Institute of Economic and Social Research
40. National Maritime Museum
41. National Museum Wales
42. National Museums Liverpool
43. National Museums of Scotland
44. National Oceanography Centre
45. National Portrait Gallery
46. Natural History Museum
47. Nesta
48. Overseas Development Institute
49. RAND Europe Community Interest Company
50. Royal Armouries
51. Royal Botanic Gardens, Edinburgh
52. Royal Botanic Gardens, Kew
53. Royal Society for the Protection of Birds
54. Royal United Services Institute for Defence and Security Studies
55. Satellite Applications Catapult
56. Science Museum Group
57. Sightsavers
58. Tate
59. Tavistock Institute of Human Relations
60. The Aga Khan University (International) in the UK
61. The Design Museum
62. The James Hutton Institute
63. The Manufacturing Technology Centre Ltd
64. The National Trust
65. The Office of the Health Economics

66. The Resolution Foundation
67. The Royal Shakespeare Company
68. The Welding Institute
69. Transport Research Laboratory
70. UK Centre for Ecology and Hydrology
71. Unlimit Health
72. Victoria and Albert Museum
73. Wellcome Trust Sanger Institute
74. World Conservation Monitoring Centre
75. Zoological Society of London, Institute of Zoology.

Eligible Catapult centres

1. Cell and Gene Therapy Catapult (Cell Therapy Catapult Limited)
2. Compound Semiconductor Applications Catapult
3. Digital Catapult
4. Energy Systems Catapult
5. Manufacturing Technology Centre
6. Medicines Discovery Catapult
7. Offshore Renewable Energy Catapult
8. Satellite Applications Catapult.

Appendix B: Research topics 2025

Topic 01
Novel S&T solutions for unexpected loss of Positioning, Navigation and Timing (PNT) capabilities

Key words: PNT (Positioning, Navigation and Timing), CNI (Critical National Infrastructure), resilience, risks, mitigation, technology.

Research topic description, including problem statement:

Positioning, Navigation and Timing (PNT) services are vital for the UK economy, as well as for critical sectors including emergency services, transport, defence, space, and energy. However, in some sectors, the vulnerabilities of PNT to both natural and ground-based interference, including through malicious attacks, are less understood. Meanwhile, over the last 15 years, the threats posed by accidental and deliberate interference and cyber-attacks have steadily evolved and increased. Examples of intentional interference range from teenagers subverting computer games e.g., Pokémon GO, to criminals attempting to flout financial trading regulations, and to numerous vessels in the Black Sea reporting GPS interference (Government Office for Science (2018, January 30). Satellite-derived Time and Position – A Study of Critical Dependencies. GOV.UK. Satellite-derived Time and Position (publishing.service.gov.uk).

We know that certain sectors are reliant on PNT to operate quickly and effectively including for critical aspects such as communications.

For this reason, the focus of this research is multifaceted. Our ideal deliverable would be to develop a better understanding of the resilience of CNI and how they would prepare for, respond to and mitigate against the risks associated with PNT. The UK already has extensive processes in place to deal with such threats, so we would like this research to focus on novel S&T solutions. Surrounding questions to this topic centre around, what steps could be taken to minimise the effect of a loss of PNT and how to effectively and efficiently operate in a PNT-denied environment.

This research will be fundamental in supporting the development of a policy response as well as shaping considerations for future technology.

Example approaches:

Current research is neither comprehensive nor prescriptive. Therefore, this project provides the researcher with an opportunity to explore, in detail, these subject matters.

We will not be overly prescriptive on the scope of this research – this research area provides you with the opportunity to shape this project in the direction that your findings take you. However, it would be beneficial to have an individual from the engineering sector to lead on this research, with a systems-engineering approach and an ability to explore and analyse deep technical aspects.

We can facilitate access to end users for this research project, if required, as well as those organisations who are responsible for our PNT-related systems.

We appreciate that this is a broad topic covering many aspects of PNT research, therefore, we would welcome any expressions of interest in all or part of the above.

Glossary:

Positioning, Navigation and Timing (PNT): PNT is a service that enables: Positioning, the ability to determine location and orientation. Navigation, the ability to determine current and desired position. Timing, the ability to acquire and maintain accurate and precise time from a standard anywhere in the world.

Critical National Infrastructure (CNI): Infrastructure that is essential for the functioning of a society and economy and deserving of special protection for national security.

Topic 02
Preparation, quantification and characterisation of trace explosive samples

Key words: trace, quantification, explosive.

Research topic description, including problem statement:

To understand the capability of explosive trace detection solutions, specific amounts of explosive material are pipetted on to swabs or surfaces for detection systems to interrogate. This allows the limit of detection (LOD) of a system to be determined but isn't very realistic when it comes to finding real traces. The thumb print test takes a known amount of explosive deposited on a surface and then stamps a standardised thumb on to it. It is then imprinted onto different surfaces or swabs multiple times, to create more realistic residues, decreasing the residual amount with each print. The current challenge of this technique is whilst the print is more realistic, the quantity of explosive within the print is unknown. So, whilst both tests combined provide a qualitative measure for how well a trace detection system performs, ideally, we require a method that combines the quantitative nature of the LOD technique with the more realistic thumb print test.

As such, although we have methods for quantifying the amount of explosive on surfaces this method is destructive (solvent extraction followed by GC/LC-MS analysis) and resource intensive. We are not able to quantify mass loading before testing a surface. We therefore require a quick, non-destructive, technique that could be used to determine mass loading on a range of different surfaces. It would also be useful to understand the surface coverage, crystal form, particle size and other characteristics.

Separately, but as part of the same topic, we would also be interested in investigating innovative techniques to enable more representative, realistic and reproducible trace contamination to be deposited onto surfaces for T&E purposes.

We could provide some examples of surfaces of interest and range of mass loadings we would need capability for.

Example approaches:

The focus of this project is to leverage emerging technology to develop a low cost, low burden solution to quantify the amount of explosive residue on various substrates.

Approaches should include the development of a prototype system.

Topic 03
The psychology of intuition - the implications associated with creativity and cognitive bias for the security community

Key words: game theory, search bias, improving decision making, human factors and security, augmented reality.

Research topic description, including problem statement:

Creative and innovative thinkers provide huge benefit to the security sector and these characteristics are highly beneficial to analysts, engineers and scientists. These individuals can identify alternative solutions to reoccurring problems and adapt to new or novel situations, giving an organization huge advantage. Furthermore, these individuals have a heightened sense of intuition compared to others even in close peer groups. However, over a period of time their creative, novel thinking can be affected by organizational cultures, group or task behaviour. This manifests as a degradation of novel thinking or indeed cognitive bias from conducting repetitive tasks. This is of particular risk to those who conduct searches and inspections and the critical element to certify an environment as secure and safe.

Currently technology is used to assist to certify an inspection environment is safe, but do end users become biased over time in the manner in which they use/ do not use the technology provided correctly? To some degree an element of intuition can lead highly skilled individuals' experimentation, whereas others do not demonstrate the heightened flare of creativity. In the latter example, this can lead to both false positives and false negatives in results. In other words: decision making can become biased over time, leading to heightened risks from the repetitive nature of the tasks.

Do individuals lose their edge due to task fatigue or is it more peripheral bias that can paralyze application of novel thinking? Are some individuals more prone to search bias than others? If so, why?

Could the application of game theory provide any insight into this? Is it possible to develop a psychometric tool that could assist with the nurturing of creativity in individual officers?

Can differences between trained individuals be measured and what technologies could be used to prompt, focus, or even train for heightened intuition/ creativity to solve a problem? The relationship between eye movements and eye tracking can demonstrate bias in an independent way.

The use of augmented reality may be beneficial both during training and on task to provide prompts for the end user. How could this technology improve the decision-making during searches and prevent or direct biased thinking?

The topic will require a proposal that is a combination of applied psychology, together with some form of engineering innovation. It will also need to present new innovative approaches that have not already been explored through research for the benefit of those who conduct routine searches and inspections.

Example approaches:

- Eye movement research is a field of psychology that has shown how eye movements and tracking eye movements, directly influenced our attention and understanding of the world around us.
- Various psychological theories have shown how task fatigue can lead to a degradation in performance.
- Technologies such as augmented reality and immersive reality have been shown to be beneficial for commercial pilots to learn in a simulated environment, how to make critical decisions when faced with a real-world event.

Topic 04
Machine learning trained fingerprinting of the near field measurement

Key words: machine learning, fingerprint, near field, electromagnetic, EM, RF.

Research topic description, including problem statement:

Electromagnetic (EM) shielding controls have widespread usage ensuring secure communication facilities do not emanate unintentional EM signals. Over the past few years near field measurement has been obtained with traditional multiprobe technique in combination with analytical functional evaluation to provide a measurement of the complex and dynamic EM field, however this approach introduces uncertainties in its measurement result due to dynamic field complexity within its surrounding. Recent advancement in Machine Learning (ML) with linear/non-linear mapping algorithms has exhibited novel techniques to solve complex analytical functions in real-time.

This topic looks for the development of fast and efficient ML integrated near field measurement within a dynamic and complex EM environment to provide fingerprinting of its surroundings for secure communication.

Example approaches:

- Literature survey for the near field measurement of EM signals.
- Near field measurement of an EM surrounding.
- Development and application of the ML algorithms integrated into near field measurements.
- Real time measurement and response accuracy enhancement within a dynamic EM environment.

References:

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- Deschriiver, D et al., doi: 10.1109/TEMC.2011.2163821.

Topic 05
Light weight metamaterial ultrawideband frequency absorber

Key words: metamaterial, absorber, ultrawideband, polarized, acoustic, RF, technical surveillance, novel materials, attenuation.

Research topic description, including problem statement:

Metamaterials have been widely used in the past few years for RF as well as acoustic shielding applications. These are typically only applicable over a limited bandwidth, and there has been limited research in the metamaterial absorber design for combined acoustic and RF application, from a few Hz up to 30 GHz. There are additional research gaps that RF absorption effects suffer from the incidence polarization of its signal, meaning that shielding often does not fulfill the requirements as desired for its application.

In this topic we would like to explore the research and development of novel lightweight metamaterial absorbers to provide the frequency absorption over a wideband range from a few Hz to 30 GHz that is insensitive to the incident signal phase. The development would help in providing an absorption and attenuation of various sound and RF signals emanating from multiple consumer devices and sources and bring new vitality into traditional approaches.

Example approaches:

- Computational modelling and calculation of the architectural design.
- Model and simulate the behavior of metamaterial absorber for its intended frequency range.
- Identifying candidate materials and novel composite structures with negative permittivity and permeability, potentially using conductor and dielectric sandwich materials.
- Optimise the design for the physical construction.
- Experimental verification of the physical design and its analysis for its application.
- Development of lightweight design for its integration within a physical space.

References:

- Zhang et al., 2020, “Engineering Acoustic Metamaterials for Sound Absorption: From Uniform to Gradient Structures”, iScience.
- Yang and Sheng, 2023, “Acoustic metamaterial absorbers: The path to commercialization”, Applied Physics Letter.
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Topic 06
Utilizing a modern mobile to provide a level of TSCM capability

Please note that applicants for this research topic will be required to undergo security vetting and must meet the necessary security clearance requirements. If the Research Fellow fails to meet these requirements or does not complete the vetting process in a timely manner, the award will be withdrawn.

Key words: TSCM, mobile phone, tablet, discrete, AI.

Research topic description, including problem statement:

Current Technical Security Countermeasures (TSCM) tools are various, expensive and a range of physical sizes. All of them together make a useful tool set, but there are operational challenges such as logistics, ease of use, discretion that are presented in their application.

The modern mobile platforms – i.e. mobile phones and tablets – are a high specification computer processor with a variety of measurement and communications sensors and transducers. These can be exploited to measure the physical world and collect information and measurement data equivalent to the TSCM tools, in a single device.

We are looking to find out how the intrinsic sensors and features on a mobile phone (accelerometers, cameras, magnetometers, Bluetooth, GPS, near field charging loops, vibrometers) can be leveraged in conjunction with software applications and software defined radio to be useful as a tool in monitoring an environmental for technical threats, such as hidden electronic, audio or visual devices.

Key questions – can a phone be used as a TSCM tool to detect hostile threats at first fix level? Secondly, how effective is that tool when compared to the specific equivalent TSCM tool. Additionally, what are the benefits of collecting data simultaneously and aggregately at scale?

Could a suite of modules apps operating the phones capabilities draw additional benefit of accumulated of data being analysed and filtered utilizing an ML or AI module to highlight data of interest or relevance, with all data recovery made to removeable media for security transfer by approved means leaving transportation of the device without sensitive data.

Example approaches:

- Downloading and comparing commercial applications for example wifi scanning and ranking for performance.
- Utilizing a bespoke overarching application to manipulate and leverage the commercial applications.
- Utilizing external peripheral devices to exploit sensing not native to the phone. Infrared camera, lenses, borescopes, microphones.
- Utilizing a bespoke overarching application to manipulate and leverage the commercial applications would this be achievable with ML or AI components.

Topic 07
Utility of synthetically generated data for training or testing AI/ML systems

Key words: synthetic, training, evaluation, testing, AI, ML.

Research topic description, including problem statement:
How feasible is the use of synthetic data, in place of rare domain specific data, to train or evaluate ML models? What are the associated risks, benefits and explainability considerations?

(Video/imagery systems are used as an example, but the topic under investigation could cover any physically or digitally collected data or data-sets.)

Scenario 1 problem statement:
It is currently difficult to train novel ML models on data that is sufficiently representative of their final use case, when not much domain specific data is readily available. Specifically:

- large public data sets tend not to exist for the specific scenarios that are of interest,
- operational data cannot be made available and/or is insufficient in quantity,
- production, curation and labelling of 'real' data to cover all variants of scenarios can be extremely costly, complex and time-consuming (eg. i-Lids).

Scenario 2 problem statement:
A model pre-trained on publicly or commercially available data has been submitted for evaluation against an operational requirement that represents a similar task.

Insufficient domain specific data exists with which to evaluate the capability thoroughly, as it has generated in an uncommon manner.

Questions to be answered:
With advancements in the ability to generate increasingly realistic synthetic data (e.g. by Game Engines in the video example), what is the possibility and utility of generating representative synthetic data to allow training of AI systems used to detect and/or identify specific content, or otherwise enrich live or large operational data feeds?

If we only have access to small amounts of real data with which to test a pre-trained AI, is it possible to synthetically extend the data to a suitably sized test set?

Can the synthetic data be generated with suitable detail to embed the desired information for later extraction?

Are AI's that have been trained this way subject to any biases in response?

Can the efficacy, accuracy or other performance metrics of AI's trained on synthetic data be relied upon when the same systems are then given 'live' data? And if not, is there a predictable performance adjustment that can be applied?

How does 'explainability' work with AI's trained on synthetically generated data?

What are the ethical considerations around the use of AI/ML systems trained on, or tested against synthetic data?

Example approaches:

Scenario 1:

- Create two 'real' datasets and one synthetic dataset, that mimic a true data type of interest.
- Train two instances of an AI, one on the synthetic and the other on the first real data set.
- Test both AI instances on the 2nd 'real' dataset and compare performance.

Scenario 2:

- Make a short 'real' dataset.
- Make a larger 'real' data set.
- Synthetically extend short 'real' dataset.
- Test pre-trained AI to ensure responses are similar to both.

NB: 'real' as used above, means a dataset that contains true data (non-synthetic) that has been mocked-up or manipulated to provide an accurate representation of operational data.

Topic 08
Bio-manufacture of quantum technology

Key words: quantum biology, magnetometry, spin-dependent biochemistry.

Research topic description, including problem statement:
Quantum 2.0 technologies have great potential. However, extensive engineering is required to deploy these cold-atom technologies. This confounds exploitation. Biological systems are thought to employ quantum mechanisms (e.g. magnetosensing in bird migration). This must happen in a wet and warm biological environment. If we can understand biological quantum sensing, it will be possible to do two new things. Firstly, the construction of new quantum sensing technologies, such as bio-magnetometers. Secondly, the bio-mechanisms that sustain quantum superposition (in wet and warm environments) may be emulated in biomimetic manufacturing to simplify and accelerate exploitation of quantum 2.0 technologies.

Example approaches:
There are a number of biochemical chassis known to be responsive to magnetic fields, e.g. fluorescent proteins (Hayward 2024 preprint) and cryptochrome flavoproteins (Hore 2024). These biochemical systems allow structure-function relationships to be explored to define the mechanisms exploited by biology to leverage quantum superposition as a biological resource.

Mechanistic insights can then be engineered in to novel biomaterials, such as new bio-parts (e.g. *de novo* designed proteins, Hsien-Wei Yeh 2023) or more complex bio-systems (e.g. persistent environmental surveillance, Tang 2021).

Topic 09
Novel approaches to space domain awareness Radio Frequency Satellite Characterisation

Key words: space, SDA, characterisation, RF.

Research topic description, including problem statement:

With space becoming increasingly congested due to the decreasing costs of access and increasing technological maturity, the ability to detect, track and characterise this increasing number of satellites is becoming ever more challenging. In addition to this, with the barriers to entry lower, there is ever greater diversity of satellite size and type; and greater complexity in understanding how satellites are operating. For safety-of-flight and national security purposes, both defence and civilian agencies are required to understand the current functional status of satellites in order to understand appropriate approaches to collision avoidance and to ensure that satellite operators in their jurisdiction are complying with license conditions.

For satellites across all orbital regimes (Low Earth Orbit, Geostationary Orbit, etc.), the UK's published Space Domain Awareness (SDA) requirements outline a variety of satellite parameters which must be determined through space object characterisation. These include the following:

- Active/Inactive status
- Status change detection
- Rotation/tumble rate
- Unambiguous unique Identification of satellites
- Attitude determination
- Mass
- Physical dimensions
- Construction materials
- Conjunction avoidance capability assessment
- Identification of satellite type/class (e.g. bus type)
- Satellite Payload identification
- Capability assessment – the overall evaluation of a Resident Space Object's payloads, ability to maintain and/or change its orbit and the operational status of various subsystems.
- History of orbital changes and manoeuvres
- Fault / Anomaly Detection
- Payload activity
- Associated Electromagnetic activity
- Damage assessment (the evaluation of damage or loss caused by an event)
- Verification of passivation procedures
- Payload deployment
- Rotation axis.

Operationally, both electro-optical and radio frequency (RF) techniques can be used to determine a number of these parameters, but different orbital regimes and satellite behaviours present different challenges to successfully addressing all characterization tasks. In many cases, novel techniques are required to provide this information at a sufficient level of detail or over longer periods of time.

The focus of this topic is to conduct research on novel RF sensors and associated data processing techniques to enhance capabilities for space object characterisation; either in directly addressing the range of characterisation parameters relevant to the UK's SDA requirements, and/or via methods to increase the duration of collected data or reduce its latency. Novel RF sensors under consideration could be similar to those classically described as radar, as well as any other different uses of the RF spectrum for sensing. Non-exclusive examples of this could be passive or opportunistic RF sensing.

It is not currently possible to meet the SDA characterisation requirements in totality at the performance level required by defence and civilian agencies. This research will aim to address this, particularly through understanding novel ways in which RF sensors and processing of data from RF sensors can contribute. It is not expected that the research under the fellowship produces more than a proof of concept or demonstration, where appropriate, as opposed to an operational system.

Example approaches:

- Novel RF sensor designs or configurations that are capable of providing characterisation information about satellites with increased performance or duration than current sensors.
- Novel approaches to RF sensor data reduction and/or processing, including the use of AI/ML techniques.
- Design of system of systems that specifically help to address the SDA requirements for duration or latency that utilise RF sensing techniques.

Topic 10
Improved spatial resolution for optical surveillance using distributed apertures

Key words: distributed apertures, synthetic apertures, sparse apertures, electro-optical surveillance, heterodyne imaging interferometry, Fourier ptychography, Fizeau interferometer, Michelson interferometer, photonic integrated circuits.

Research topic description, including problem statement:

The larger the primary lens or mirror diameter of an optical system, the better its diffraction-limited spatial resolution and the more detail there can be in the image. However, increasing the diameter of the single primary lens or mirror beyond a certain point becomes impractical due to factors such as weight, portability, optical aberrations, robustness, system volume and expense. Using larger monolithic primary lenses or mirrors for covert, mobile, standoff, high-spatial-resolution surveillance becomes less viable.

This work will break this limitation by combining several smaller optical systems to achieve higher spatial resolution imaging. This disruptive approach using distributed apertures could not only create a system with smaller volume, weight and cost, but one that is conformally integrated into the surfaces of vehicles or other items for covert disguise.

There are many different distributed aperture techniques but most would not be practical for mobile platform operation of standoff high-spatial-resolution surveillance in the visible to long-wave infrared wavelength range. The challenges of making a practical mobile distributed aperture optical system include:

- Mechanical vibration and thermal effect resistance without requiring a rigid structure that is heavier than a conventional monolithic telescope.
- Having a low setup and alignment time.
- Fast acquisition time to capture fast-moving images.
- Having no nulls in its 2D MTF plot out to its maximum spatial frequency.
- Consideration of atmospheric turbulence compensation.

Example approaches:

Example approaches include distributed apertures techniques that seek to replace one large telescope with an array of smaller apertures (lenses, mirrors or cameras etc.) or to use multiple illumination angles. This includes:

- Heterodyne imaging interferometry with passive scene illumination.
- Fourier Ptychography aperture synthesis snapshot imaging with active coherent scene illumination.
- Michelson Fourier-domain interferometric imagery using photonic integrated circuit (PIC) boards to form a planar (flat) telescope with passive scene illumination.

Topic 11
Ocean acoustic modelling for superior environment intelligence

Key words: sonar, underwater acoustics, ocean, measurements, modelling, data, information, intelligence, surveillance, reconnaissance.

Research topic description, including problem statement:

Next Generation and Generation After Next sonar superiority in the underwater battlespace will depend significantly on our understanding and exploitation of the ocean acoustic environment. Understanding acoustic behaviour in the ocean environment, and acoustically-relevant properties of the environment, is highly complex depending on a wide range of factors that change both spatially and temporally across multiple scales – even on the calmest days, the ocean is constantly changing, under the influence of a wide range of complex and dynamic ocean-acoustic factors. Presently, only the simplest acoustically-relevant properties of the environment are well described by measurements and only the simplest ocean-acoustic factors are considered in modelling.

This research topic aims to combine several research challenges to produce a plenary ocean-acoustic model that can digest complex ocean-acoustic data and generate superior intelligence about the ocean-acoustic environment, reflecting a greater understanding of acoustically-relevant properties of the environment, which can be exploited for the purposes of intelligence, surveillance, and reconnaissance, as well as commercial monitoring of the ocean. Research challenges include:

- Mathematical descriptions of acoustically-relevant ocean properties, such as internal waves, eddies, and spice, covering multiple spatial and temporal scales.
- Development of physics based, data driven, or hybrid acoustic models, including noise and propagation models, to describe acoustic behaviour in the presence of different acoustically-relevant ocean properties.
- Sensitivity and uncertainty analysis and quantification, based on the quantity and quality of input environment data to ocean-acoustic models.
- Investigate the computational efficiency and accuracy of different models, including different model configurations.
- Development of schemes to generate, visualise, and exploit the best available description of the ocean acoustic environment.
- Investigate ocean-acoustic models, and other methods, to monitor the health of, and changes to, the ocean environment.

Example approaches:

The research challenges can be approached using a mix of applied mathematics, programming, statistics, data analysis, and machine learning. Examples approaches include:

- Develop an underwater acoustics foundation model to understand and process ocean-acoustic data and to generate ocean-acoustic information for different applications; this could include the design and conduct of large scale data collection and preparation activities and other data collection to enable fine tuning for specific applications.
- Develop new analytical and numerical models to understand and predict acoustic behaviour in a variety of different environment conditions; this could include the development of methods to synthesise a variety of acoustically-relevant properties of the environment and to represent these properties in the acoustic models.
- Develop an efficient framework or architecture for combining different ocean models and acoustic models; this could include the design and development of intelligent hybrid models that optimise the combinations of models based, for example, on uncertainty or computational efficiency.

Topic 12
Aging of fingermarks. Can fingermark deposition time be determined from crime scenes/objects?

Key words: forensics, fingerprint, fingermark, visualisation, detection, enhancement, fingerprint analysis, aging.

Research topic description, including problem statement:
Deposited friction ridge detail (i.e. finger or palm marks) are often recovered from crime scenes/ and/or objects, in order to assist with forensic investigations. However, determining the age of a fingermark remains a challenge, as current methods lack accuracy and reliability in estimating the age of fingermarks. Being able to reliably age a fingermark would be extremely valuable to a broad range of investigations as it provides a timeframe of events. There is also an opportunity to evaluate transfer and persistence in combination with the aging of fingermarks.

Example approaches:
The approaches to tackling this problem can be broad, but commonly include identifying a chemical change as a function of time and using a form of spectroscopic analysis to measure it i.e. mass spectrometry. This approach would leverage the precision of mass spectrometry to detect and analyse the chemical changes in fingermarks over time, in order to determine their age. This is only one example of an approach, with more in-depth studies being envisaged.

Topic 13
Exploiting biology for overmatch compute advantage

Key words: molecular compute, biological compute, organoid intelligence, chemical reaction networks, algorithms, computer science, biology, DNA, RNA.

Research topic description, including problem statement:
Whilst there is a continued push for faster, cheaper, lower power compute, much of this effort is placed into further developing proven technology, specifically silicon, either by continual scaling (Moore's Law), or by adapting architectures (SysMoore and Amdahl's Law). These developments, and other factors, mean silicon-based approaches will continue to provide the main core of computing resource for a considerable time. However, other computing approaches have the potential to provide extraordinary benefits, especially for particular applications.

There are currently three types of computer in widespread use: silicon-based; living brains, which have prompted significant research in artificial intelligence and neuromorphic computing; and Chemical Reaction Networks (CRNs), which (for example) control the behaviour of every cell in the human body. Despite their prevalence, in comparison with other approaches, CRNs and other types of bio-based computing are heavily under-investigated.

As evidenced by their ubiquity in nature, bio-based computing approaches offer potential advantages over other forms of computation. For example, they can solve NP-complete problems1 and they exhibit different scaling properties to conventional (and quantum) computing[2]. Bio-based approaches can also operate at low-power and in environments that are hostile for traditional electronics.

This research topic aims to understand, develop, and evaluate (algorithmically) bio-based computing technologies that may provide Intelligence (and wider Defence) benefit, as well as facilitating a shift toward an evolutionary-proven, low-power compute solution. Challenges include:

- Evaluating and comparing different bio-based computing technologies.
- Developing a range of practically-useful algorithms using bio-based computing methods (including, massively parallel approaches, using either concentration-based or string-based encodings).
- Identifying integration and deployment challenges, to establish feasible routes toward exploitation.
- Specifying verification, test, assurance, and robustness considerations, together with potential methodologies that would allow bio-based computing approaches to be used with confidence.

Example approaches include:

- Assessing the merits/demerits of bio-based computing for different classes of compute problem, through:
  - identifying key real-world problems that are well-suited to bio-based approaches and clarifying which problem characteristics are key to this suitability;
  - establishing sound development methodologies for bio-based computing (e.g. string-encoding approaches, which can be designed and simulated in available languages such as Thue[3], or differential-equation based approaches, which represent concentration-based implementations);
  - using these methodologies to implement appropriate algorithms that exploit (and demonstrate) bio-based computing's unique properties;
  - proving conceptual algorithms through experimentation, using new or existing bio-based computing technologies;
  - comparing the effectiveness of bio-based computing with other computational paradigms (including silicon-based approaches), considering repeatability, robustness, timeliness, monotonicity, security, and Size, Weight, Power and Cooling requirements.
- Developing integration methods for bio-based computing (e.g. interfaces with traditional computing, human-machine interfaces), including miniaturisation strategies of supportive interfaces, and identification of missing, or under-developed, components required for exploitation.
- Understanding the potential offered by DNA-based storage, especially in combination with "processing in memory" techniques.

References:

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[3] https://esolangs.org/wiki/Thue.

Topic 14
Integrating multimodality and context to automatic language analysis

Key words: linguistics, forensic linguistics, applied linguistics, computational linguistics.

Research topic description, including problem statement:

There are two main underlying problems with automatic approaches to language analysis: a lack of ability to account for context, and a lack of interpretability of language across different modalities (for example, audio, image, video, and text). Human communication is exceedingly context dependent. As a simplified example, if I state that the table needs to be moved a listener will automatically use context clues to indicate whether I mean an item of furniture, or an excel style table. These might be physical context clues, or indicators from the co-text. When people are talking about sensitive, taboo, or illegal topics, this reliance on context increases even more. Automatic language tools are improving at utilizing co-text to help improve the accuracy of work, but they are still limited in the range of context that can be considered.

Online communications are exceedingly important to the intelligence community, and increasingly multimodal. This might be a soundtrack which changes the intended meaning of a picture (for example a classic circus soundtrack over a social media video of me parking my car, indicating that I am not showcasing my excellent parking skills but encouraging ridicule), or an emoji pasted over the top of an image (for example a picture of snow, with a nose emoji, indicating that the post is about nasally inhaled drugs rather than snow). Cross-modal communication like this is now the norm in many groups and societies, and that is particularly the case when discussing taboo (or illegal) topics.

Dover (2022) highlights how significant the internet and electronic communications are to intelligence communities. Automated approaches to language analysis can enable the quick triage and handling of significant amounts of data, however where they struggle significantly is with bringing together meaning from across different modes. This means that a significant amount of the communicative content risks being lost before it reaches an analyst.

These changes in meaning provided by either the context or the different modalities might be instantly understandable to us as humans, but an automated approach that struggles to consider such aspects, will provide a severely limited output. The topic here is designed to seek ways to combat these two problems – to integrate a holistic understanding of language with automatic language approaches. The desire is that the outputs will therefore be grounded in applied and sociolinguistics and able to address language and communication in a more accurate and reliable way, considering how language actually functions.

Example approaches:

The exact approach will depend on the form of automatic language analyses that are being considered, though researchers will need to source their own data set(s) to show a proof of concept. An overarching example approach would be starting from a sociolinguistic or corpus linguistic perspective and seeking to ensure that the understanding of how language works remains in the automated approaches. This is supported by the literature, most notably Grieve et al. (2024), who in their recent paper on the Sociolinguistic Foundations of Language Modeling conclude that "incorporating insights from sociolinguistics is crucial to the future of language modeling" (p17).

However, the benefits of such integration has a much longer trail of evidence. For example, in a 2013 Native Language Identification challenge (sometimes called Other or Native Language Influence Detection), where participants seek to identify an author's first language (when they are writing in English), Bykh et al. (2013) achieved a higher classification accuracy that other participants through using linguistically-informed features in their classifier. This included features such as parts of speech, lemma realisations and use of derivational and inflectional suffixes. Further work on Other Language Influence Detection for forensic linguistic purposes by Kredens, Perkins, and Grant (2019) highlights how vital an explanatory rich approach (such as one grounded in sociolinguistic explanations and features) is to analysis of language in evidential and investigative situations.

Focusing on the concurrent analysis of both the verbal and visual aspects of Instagram posts at the same time, Caple (2018) shows that taking a corpus-assisted multimodal discourse analysis can reduce partiality and enable triangulation. Polli and Sindoni (2024) look at the multimodality in hateful memes, and that the interplay between non-hateful text and non-hateful images can be used to produce hateful messages. They note that multimodality is conceptualized differently across the domains of computer science and sociosemiotics, however they also show that AI driven models can benefit from sociosemiotic insights and incorporating a multimodal critical discourse analysis approach.

More specific focused example approaches might include:

- Given a set of political speeches or news reports that happen over time in a changing context (e.g. during a conflict), how could an understanding of context improve topic modelling, document summarisation, an understanding of the evolution of events, or other forms of automated analysis? This could include (for example) the change salience of different places or people during the conflict, or a need to show strength to an audience in reaction to provocation.

- Given a set of social media posts with associated images (e.g. memes), how could an understanding of meaning and mood be better extracted from the multi-media content? For example, memes such as Wojak and Pepe the frog are often adapted quickly to express emotion reactions and humour at a given situation – how could that data be analysed alongside the text to give a more nuanced understanding of messages. Another example would be when images are used to convey instant emotional impact – for example in Daesh propaganda, CGI from video games was used to make it seem like the Eiffel tower had been attacked, or during the 2011 London riots images were shown of the London Eye on fire. Images like this may have more impact than just text messages.

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Topic 15
Barriers to adoption of a security-minded approach to information management

Key words: data sharing, open data, data aggregation, data quality, provenance.

Research topic description, including problem statement:

Adoption of digital engineering practices, e.g. design collaboration using cloud-based computer aided design (CAD) software has led to a dramatic increase in the volume of information and technical data shared between organisations. Alongside this there has been adoption of a culture of greater openness and sharing of organisations' information, e.g., adoption of policies such as presumed open. These developments potentially undermine good security practices by increasing the quantity and quality of data available to those conducting hostile reconnaissance or espionage.

This research seeks to explore the attitudes, awareness, and understanding of organisations and their managers regarding the risks inherent in data/information sharing. Aspects that could be investigated include:

- Understanding by organisations and individuals of risks arising from sharing data and information with third parties.
- Understanding by organisations and individuals of data aggregation and its potential to magnify data sharing risks.
- How organisations and individuals assess the sensitivity of data and information.
- The identification, understanding, adoption and use of methods or techniques to establish information needs.
- The assessment of the provenance of data and information.

Example approaches:

- Surveys and interviews of personnel employed in CNI sectors, e.g. water, energy, transport.
- Workshops to explore attendees understanding and use of security triage processes.

Topic 16
Can obscured biometric markers be detected from crime scenes/ objects with skin barriers in place?

Key words: forensics, DNA profiling, fingerprint analysis, human identification, attribution.

Research topic description, including problem statement:
Deposited friction ridge detail (i.e. finger or palm marks) and human DNA are often recovered from crime scenes/ and/or objects, in order to assist with forensic investigations. The use of gloves and/or other physical hand/skin barriers may impede the recovery of friction ridge detail and reduce the amount of DNA deposited on a surface. Despite the use of a barrier, modern fingermark visualization techniques may be able to capture glove prints or possible friction ridge detail that could be used for forensic intelligence or evidential purposes. An evaluation of different glove types, textures, materials, and use methodology (e.g. double gloving) will provide important information on whether intelligence or evidential friction ridge detail can be recovered despite hand/skin barriers. There is also an opportunity to evaluate these types of barriers on their effectiveness of reducing touch DNA deposition.

Example approaches:
An artificial finger pad could be used to test deposition of glove marks onto a variety of surfaces such as polymers, metals, and porous materials. The finger pad allows for controlled pressure deposition and can be adapted to also be used with artificial and real human fingerprints to test deposition with gloves or other skin barriers. Similar mechanisms could also be used to test for deposition of DNA. This is only one example of an approach, with more in-depth studies using human volunteers being envisaged.

Topic 17
Autonomous AI-powered red teaming for enhanced cybersecurity

Key words: Artificial intelligence (AI), Machine learning (ML), Deep learning (DL), cybersecurity, red teaming, penetration testing, vulnerability assessment, zero-day exploits, autonomous systems, cyber threat intelligence, network security, endpoint security, advanced persistent threats (APTs), Security information and event management (SIEM), intrusion detection systems (IDS), intruder prevention systems (IPS), security orchestration automation and response (SOAR), threat hunting, cybersecurity analytics, generative adversarial networks (GANs).

Research topic description, including problem statement:

In some government and national infrastructure facilities, isolated computer networks exist due to legacy systems or high sensitivity levels. These critical systems must be defended against from cyber-attacks from hostile actors, necessitating rigorous testing of blue cybersecurity teams' response to potential network breaches and identification of vulnerabilities introduced by the configuration changes or new equipment. While penetration testing can identify existing vulnerabilities and assess blue team response, this research focuses on developing autonomous AI-powered red agents that can comprehensively test entire cybersecurity systems and detect vulnerabilities. To accelerate testing, AI-driven automation of red agent testing is proposed, which may also involve competition with AI-powered autonomous blue agents.

The research question: How can autonomous AI-powered red agents be designed to effectively identify vulnerabilities in isolated computer networks, simulate real-world attack scenarios, and enhance the overall cybersecurity posture of critical facilities?

Example approaches:

There are two approaches outlined that should be considered:

- Stealthy approach: The red agent operates covertly, using advanced techniques to evade detection while identifying and exploiting vulnerabilities.
- Rapid exploitation approach: The red agent takes a more overt approach, rapidly identifying zero-day vulnerabilities and exploiting them quickly, simulating a real-world attack scenario.

The proposed approach may involve the development of a hybrid AI framework that combines traditional cybersecurity techniques with generative AI and machine learning algorithms. This framework will be designed to simulate various attack scenarios, including network vulnerabilities, phishing attacks and unauthorized device identification.

This research will push the boundaries of current AI-powered red agent technology by developing a novel framework that can adapt to evolving attack scenarios and learn from experience. This will ultimately enable the development of more sophisticated and effective cybersecurity testing and evaluation methods for blue teams.

Topic 18
Novel methods for structural health monitoring and detection of faults

Key words: non-destructive testing, quantum, gravimetry, magnetometers, materials, concrete, steel, density differentials, Infrastructure, structural health monitoring.

Research topic description, including problem statement:

The Reinforced Autoclaved Aerated Concrete (RAAC) scandal caused major concerns in public infrastructure in 2023, some of which are ongoing. This highlighted the industry of non-destructively building materials testing in both new and long-standing infrastructure. For concrete, reinforced steel and other building materials, there are well established methods to non-destructively test, including penetration testing, the rebound hammer method and ultrasonic testing.

However, the defence and security want to explore emerging technologies that may be able to detect defects and offer high levels of penetration to building materials such as concrete and steel, for rust, micro material density differentials and other subtle defect detection.

Example approaches:

The approach to this could be split into multiple routes, through testing a variety of technologies to a variety of building materials focusing on hard to detect defects and material density differentials. Narrowing this down early on will be key to directing the research in the most appropriate manner based on what is available.

Examples of technologies which could be used range from classical to quantum.

- Gravimetry would be a very interesting technique to explore, particularly from the view of understanding the different gravitational properties of different building materials and whether you could also “classify” an unknown material based on its gravitational properties.
- A light array could be used to see how much light passes through the material. Understanding what wavelengths would be optimal for this, which could also be used outside of a laboratory environment whilst meeting safety regulations, would be critical to the exploration of this methodology.
- Concrete is known to have a low-level magnetic field. Exploring the changes in this magnetic field based on how complete the concrete pour is could enable the identification of faults with the concrete.

There may be other approaches than these which we would be very interested to hear about.

Topic 19
Identifying hazardous materials using spectroscopic or quantum sensing techniques

Key words: quantum, spectroscopy, chemistry, physics, imaging, organic materials, detection.

Research topic description, including problem statement:

The defence and security community have a need to detect materials of concern at a stand-off distances, at low parts per million, and enable a method to locate the source. For example, law enforcement, Home Office, Border Force and military applications users have the need to detect illegal narcotics, organic materials, hazardous chemical and biological items of concern.

There exist many methods to detect explosive materials for example, this research question is focused on emerging technology that can detect very low quantities at stand-off distances, tuned to certain materials.

Example approaches:

Classical and quantum technologies could be used to explore this work.

- Classical spectroscopic techniques could be used for detection through creating fixed wavebands and utilising characterisation techniques such as those used with Raman spectroscopy systems. Methods such as producing stimuli responsive luminescent particles that respond by fluorescing when exposed to certain pre-defined compounds.
- One possible route to research this involves colloidal quantum dots tuned to different optical wavelengths. The wavelengths would be tuned depending on the organic material of interest, but also the number of optical wavelengths which can be characterised at one time. Considerations would include how an array of dots could be utilised and deployed, tuning the spectral range to gain the necessary spectral resolution, and choosing the illumination method will be needed to ensure the right level of excitation of organic matter for characterisation.

Topic 20
Wideband Electromagnetic field measurement with a low cost, size, weight and power Quantum sensing solution

Key words: quantum, electromagnetic, electric, magnetic, RF, wideband.

Research topic description, including problem statement:

Quantum sensing development has provided novel methods to capture various electrical parameters with a wide array of sensing solutions including the Electrical/ Magnetic/Electromagnetic field measurement however for its limited research and design, the EM field measurement is still at the nascent stage. This is further exacerbated with the absence of low cost, size, weight and power developmental solution. However, with the progress in Quantum sensing for its various technological solutions based on entangling, interference mechanism, Rydberg atoms and Nitrogen Vacancy detector have provided a hope for the sensitive, precise and low-level signal strength EM measurement at single frequency or limited bandwidth. The additional research gaps arise due to the sensing mechanism protocols for continuous, pulsed or mixed dynamical coupling and the absence of non-classical mechanism of processing at quantum level. The quantum sensing development would provide a low cost, power and portable mechanism for the metallic/non-metallic detection within a high precise EM field and weak signal strength in a noisy environment while bringing new vitality in the EM field sensing approach.

Example approaches:

- Computational modelling and architectural design.
- Optimize the design for the physical construction.
- Experimental demonstration of the wideband EM field measurement.
- Real time measurement and response accuracy enhancement within a dynamic EM environment.
- Development of lightweight, low power design for its integration within a physical space.

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Topic 21
Advanced processing for real-time RF mapping

Key words: RF mapping, signal processing, machine learning, artificial intelligence, real-time analysis.

Research topic description, including problem statement:

Radio frequency (RF) mapping involves monitoring and analysing electromagnetic signals to identify, locate, and track a range of communication devices. It is an important tool used across various fields to understand the electromagnetic landscape in a given area. However, this process comes with challenges such as the complexity of signal propagation in different environments, interference from multiple sources, and the dynamic nature of signals over time. Optimising RF mapping to enhance its effectiveness, precision, and efficiency is becoming increasingly important as communication technologies continue to evolve.

The ability to analyse RF data in real time is crucial for a range of applications; however, this is associated with technical and operational challenges that must be addressed to achieve accurate and efficient outcomes. Urban environments have a high density and diversity of wireless signals, generating a large amount of data during RF mapping. This creates significant noise and interference that complicates efforts to isolate relevant signals and interpret useful information in real time. Traditional processing methods struggle to handle the volume and complexity of this data, making it difficult to provide the real-time analysis that is necessary for quick decision-making. Reducing the time delay between data collection and acquiring actionable insights would have significant implications in a number of fields. Therefore, innovative approaches are required to streamline RF data processing, enhance analytical capabilities, and generate rapid outputs.

Example approaches:

To address these challenges, more efficient methods capable of filtering and analysing large volumes of RF data in real time are required. A key focus will likely be the application of machine learning and artificial intelligence tools, which can be trained to recognise patterns, filter out irrelevant signals, detect anomalies, and prioritise actionable data in congested spectrum environments.

Proposed methods should be able to dynamically adapt to changing signal environments and accurately recognise common sources of interference. Edge computing approaches could also be considered to help process data closer to source to enable faster decision making in critical situations. Potential solutions should also be designed with scalability in mind to accommodate the growing network of modern communication devices. Additionally, consideration should be given to the integration of RF mapping data with other data sources in order to enable improved accuracy, provide better context, and achieve a more comprehensive understanding of the signal environment.

Topic 22
Central bank digital currency technology: the impact on global finance and implications for national security

Key words: central bank digital currencies; cryptocurrency; global finance; money laundering; sanctions evasion; serious and organised crime; blockchain.

Research topic description, including problem statement:

Members of the BRICS community of states are seeking to establish Central Bank Digital Currencies (CBDCs). Trials of national CBDCs are currently taking place in several BRICS member states with the aim of expanding these by 2025, with plans to include over 30 banking institutions. The CBDCs will be utilized for cross-border payments within the BRICS community.

It has been confirmed that mBridge, developed in collaboration with the Bank of International Settlements (BIS) and both BRICS and non-BRICS members, has now reached the minimum viable product (MVP) stage. mBridge is being developed to support peer-to-peer and cross-border payments, built on a blockchain platform known as the mBridge Ledger. This blockchain is expected to be compatible with the Ethereum Virtual Machine (EVM), the foundation of the Ethereum network and its decentralized finance system (DeFi). Such compatibility indicates a potential for CBDCs to integrate with the existing cryptocurrency ecosystem.

Reports from blockchain forensics entities confirm the illicit use of cryptocurrency by both state-linked and non-state actors, including serious and organized crime (SOC) groups, cyber criminals, terrorist financiers, and sanctions evaders. Tracing of crypto transactions is possible across most blockchains within the crypto ecosystem; however, it remains unclear whether ledger technology supporting CBDCs will be compatible with current tracing software. Similarly, privacy protocols for CBDCs, particularly regarding user anonymity and pseudonymity, have yet to be established.

There is currently limited academic research on the issues highlighted here. Some publications explore aspects of CBDC architecture such as the security risks in CBDC systems, emphasising challenges such as de-anonymisation through methods like multi-party computations and zero knowledge proofs [1], the privacy trade-offs in CBDC architecture design [2], and the geopolitical implications of a BRICS-led supranational CBDC [3]. However, as CBDCs are an emerging technology, their integration and use by both legitimate and hostile actors is poorly understood. Therefore, research is required to understand the underlying technologies that support CBDCs and to identify current or future methods for tracing these funds within the wider global financial system.

Research should aim to examine potential use cases, their impact on global finance, and how they may be integrated into financial systems. It should also explore the threats and opportunities for hostile actors, including sanctions evaders, SOC groups, cyber criminals, and state-linked actors, to move funds undetected.

To understand the evolving landscape of CBDCs, several critical questions must be addressed. With a focus on the BRICS community, what is the current state of CBDCs, including which are currently in use and by whom? What technology underpins them and how do they interact with existing fiat and digital currencies? Are the technologies underpinning the CBDCs compatible with the blockchain technology that currently supports cryptoassets? What opportunities exist for tracing transactions across existing and future CBDCs? Additionally, what technological and methodological barriers hinder tracing these transactions, and how do these challenges differ from those associated with established cryptocurrencies?

Example approaches:

- Investigate how blockchain or similar distributed ledger technologies (DLT) can be integrated into the structure of the CBDCs for adoption by BRICS members.
- Assess the capacity of BRICS CBDCs to connect with the existing cryptoasset ecosystem, including an evaluation of the compatibility of the underpinning technologies.
- Explore opportunities for tracking and tracing transactions completed by users of BRICS CBDCs.

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Topic 23
Performance improvement from antenna diversity from space platforms

Key words: spatial antenna diversity.

Research topic description, including problem statement:
With lower cost brought about by 'New Space', there is growing interest in clusters of satellites operating together to provide spatial diversity for antenna systems for the purpose of increasing performance at a lower cost than a large single aperture antenna.

This research topic is about exploring, through simulation and practical experimentation, the performance improvements e.g. sensitivity, bandwidth improvement together with features such as interference rejection and geolocation as a minimum. The research is likely to include methods for coherence across platforms and efficient communications to facilitate spatial diversity.

Example approaches:
Spatial diversity, Pattern diversity, Polarization diversity, Transmit/Receive diversity, Adaptive arrays.

Topic 24
Development high-throughput informatic tools to support proteomic analysis in complex samples

Key words: AI, computational, methods, bioinformatics, biothreats, mass spectrometry, proteomics.

Research topic description, including problem statement:
Analysis of protein samples collected for law enforcement or intelligence purposes are frequently of low quantity and poor quality. Proteomic analysis provides critical information to support the attribution process. The IC laboratories frequently utilize mass spectrometry to identify key peptides in a protein. This project seeks to develop informatic processes that can support the identification of novel proteins with confidence scores that would be linked to specific peptides or groups of peptides identified in public or private databases.

Example approaches:
- Develop an algorithm that exploits the robust protein sequence databases available to compare partial sequence information.
- AI has been successfully applied to predicting the structure of proteins; use the same approach to provide possible protein “matches” based on partial sequence information from MS analysis.

Topic 25
Advanced Techniques for Antenna-Receiver Performance Enhancement and Miniaturization (ATARPEM)

Key words: SWaP, electrically small antenna, bandwidth, efficiency, amplification, RF, receiver.

Research topic description, including problem statement:
The IC often requires communication systems working under severe size, weight, and power (SWaP) constraints (e.g., space, man-portable). This is particularly true when RF antennas are small in relation to the wavelength of operation which sets limits on the efficiency, bandwidth, sensitivity, or other properties of the communication system. Recent approaches to overcome the limitations of electrically small antenna systems include antenna-amplifier codesign, predistortion and feedback, direct antenna modulation, on-board parametric amplification, and fast antenna tuning.

Example approaches:
- Predistortion of transmitted waveform to account for dispersive impedance with nonlinear, adaptive amplifier.
- Direct antenna modulation (DAM) where an antenna is driven directly without the waveform passing through an amplifier.
- On-board parametric amplification used to increase receive sensitivity or transmit bandwidth.
- Antenna tuning faster than the sample rate to increase bandwidth or enable broadband waveform transmission.

Topic 26
Enhancing the effectiveness of routine security scanning checks at border crossings

Key words: X-Ray, Computed Tomography (CT) scan, behavioral science, Artificial Intelligence (AI), crowd monitoring, machine vision, machine learning, distributed sensor network, pattern recognition, public transport ticket Information.

Research topic description, including problem statement:

Security checks at border crossing points provide a crucial detection function for a wide range of items including weapons, explosives, liquids, sharp objects, pills, as well as many other objects that may be hidden on a person's body or in their luggage. A range of detection technologies are used at these security check points, including X-Ray and Computed Tomography (CT). Modern systems employ advanced technologies including Machine Learning (ML) and Artificial Intelligence (AI) to enhance performance of the tool and reduce the workload of the human operator.

These tools analyse the scene and highlight areas of potential concern for the operator to scrutinise, ranked in priority according to a defined, yet adaptive risk profile. Although these systems are highly effective, the reliable detection of evolving threats in a complex environment while avoiding excessive false positives, maintaining low latency and high throughput is a significant optimisation problem.

While the effectiveness of these tools is beyond the scope of this research proposal, we seek to investigate and build understanding of the potential for improving the effectiveness of these tools through augmentation with external data analysis to increase the likelihood of threat detection.

Example approaches:

External data analysis could include processing of a range of data sources to identify anomalous characteristics, including but not limited to:

- Ticketing data (routes, purchase lead times, payment system used, visas, passport type).
- Pose, gait, body language, biological indicators on approach to scanning systems.
- Luggage and carried item object classification/combinations.

Topic 27
Using AI to power synthetic biology applications

Key words: multi-omics, synthetic biology, Artificial Intelligence.

Research topic description, including problem statement:

The increasing availability and volume of multi-omics data, technical knowledge and tools, and the advance of Artificial Intelligence (AI) capabilities is revolutionising science. AI powered synthetic biology stands to alter the biological threat and opportunity paradigm and raises unique challenges that need to be better understood.

Synthetic biology is an evolving and diffusing technology, new developments in AI, and notably the improvement of generative AI, have opened the door to additional creativity in synthetic biology. For example, large language models (LLMs), have been adapted to the genetic code by replacing words with the nucleotide bases. This enables LLMs to optimise experiments to generate new DNA sequences (and thus new virtual organisms) precisely, quickly and cheaply. The resulting molecules organisms and knowledge promise to be useful in accelerating drug discovery, food engineering, conservation of biodiversity, climate remediation and the understanding of life. Generative AI could be used to predict the outcomes of gene editing experiments. This will reduce time spent investigating eventual dead ends, broadening the scope of testing and deliver savings in cost and time. Those applications are like software engineers' use of generative AI to test code.

What are the possible applications stemming from AI powered synthetic biology? What are the risks and vulnerabilities of employing or not employing AI powered or supported synthetic biology? What do international research trends suggest are the major development or investment directions? How might potential concerns be mitigated?

Example approaches:

Research proposals could approach this issue from a variety of disciplines, or as a cross-disciplinary effort. The challenge touches on aspects of synthetic biology, AI, future applications, transnational issues, ethics and privacy. Proposals could consider (but are not limited to):

- The utility of AI platforms to; enhance current or develop novel synthetic biology tools/techniques and/or generate novel tools/techniques for the detection of modified organisms.
- Combining AI and multi-omics data, including proteomics, genomics, metabolomics, and transcriptomics to provide a more holistic view of biological systems.
- The use of generative AI to accelerate synthetic biology applications.
- With respect to AI development trends, evaluate the coordination among domestic and global stakeholders for monitoring, assessment and mitigation of risks associated with advances in synthetic biology research and applications.
- Evaluating the international societal effects and public policy implications, with respect to privacy and social license guardrails, of synthetic biology research and development.

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